

VEGETATION FORMS

A classification of stands of vegetation based on structure, growth form of the components, and vegetative periodicity.

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INTRODUCTION

In 1961 FOSBERG published a classification of terms for vegetation on a world basis, based on rough categories of height and spacing of the various layers, on leaf size and consistency, on certain other minor structural characteristics such as gnarledness and thorniness, and on the deciduousness or seasonality of the stand. The terminology was meant to apply to *stands* of vegetation, large or small, at any stage of succession or disturbance, and therefore was not meant as a classification of vegetation types in the sense of large scale floristic-geographic units such as are usually found in accounts of the vegetation types of a country. A stated aim was to exclude environmental conditions and terms since the classification was to be of the vegetation alone and not of the ecosystem of which the vegetation is a part. In this way, the vegetation could then be compared with independent estimates or measurements of the local environmental factors to see what correlations hold. Thus, terms like "tropical rainforest" were excluded, for this is a name for an ecosystem, not for a form of vegetation.

FOSBERG's system followed a number of criteria, not all of which had been followed by earlier non-floristic systems: (1) the attempt to exclude environment in the definitions and terminology of the categories, (2) names were used, that is, short expressions in words rather than a formula, (3) a larger number of categories was defined than in older systems using short names, hence finer characterizations could be named. Also, for whatever advantage it may or may not have, an English rather than a Latin or Greek terminology was employed.

Formula systems, such as that of KUCHLER (1949, 1950) or DANSEREAU (1957), convey more information than FOSBERG's terms, since cover, grades of height, leaf characters and deciduousness of *all* of the four distinguished layers are included, not only that of the dominant or conspicuous layers. The formula method, of course, is also an excellent one for quick recording in the field. However, its translation into words is often too lengthy to be used as *name* for a vegetation form, although it is very useful as a short description.

There are many occasions where names for stands are necessary and I believe the basic idea of FOSBERG's system is a useful one. My justification

for presenting a modification of it in this paper is (1) to eliminate certain inconsistencies, (2) to provide for combinations of height and spacing not covered by FOSBERG's system as it stands, (3) to restrict the number of criteria employed to those that can be seen in a glance and, where possible, at a slight distance from the individual plants that make up the stand, (4) to offer a fuller discussion of the categories and their classes, (5) to choose what I believe are better terms in some cases, and (6) to simplify the presentation in list form of the final categories ("vegetation forms").

I do not think it is necessary here to justify a system based on the vegetation cover alone and that does not consider the environment in any way. It is difficult to make most plant ecologists realize the value of categories based only on the visible aspect of the stand, although it is obvious that some such terminology is necessary if the causes of that aspect are not going to be prejudged by being implicit in the name. The history of the concept of "xerophytism" should warn us that the causes for the visible aspects of vegetation are not always so obvious as they might appear. Therefore, an ecologically neutral terminology would be very useful. Geographers, plant sociologists not primarily concerned with the causes for a particular vegetation, classifiers of terrain for various purposes, etc., probably will find the system presented here helpful in providing a uniform terminology that may be used anywhere in the world.

Categories based on gross aspect are to a large extent independent of the environment. Similar vegetation forms may occur in very different ecological situations either in the same local area or in different parts of the world. Thus, as far as the vegetational structure itself is concerned, and at the degree of precision we are using, a rocky ledge covered with a carpet of *Polytrichum* moss with scattered low grasses is equivalent to a sphagnum bog with scattered *Eriophorum* sedges; both are closed mossy layers with scattered graminoid plants. Ecologically, of course, they are opposites: one is an early stage in a xerosere, the other an early stage in a hydrosere. A forest of a particular structure, such as would fall into only one of the categories adopted in this paper, for instance, a deciduous, mesophyll, non-sclerophyll forest, may be found in the same region on thin soil over rock, on a deep well-drained soil, or on a swampy soil. The differences that would correlate with the edaphic environment in these cases might be found in more recondite structural characters of the canopy plants, in the structure of the lower layers, in underground parts, in floristic composition, and in the physiology of the individual species and ecotypes.

The environment impresses itself upon the physiognomy and structure of vegetation in many ways, both upon gross aspects of height and cover and upon fine details. Often the environmental impress is gradative, a slightly drier site, for instance, making for slight changes in average leaf size, leaf form and sclerophylly, in bark characteristics and thorniness, as well as in height and cover and in species or ecotypic composition. But which physiognomic and structural characteristics change with dryness of site varies from region to region because of different climates, rock composition, available flora, etc. Sometimes very fine distinctions have to be made. For example, one would

have thought that RAUNKIAER's six leaf size classes would be enough to register any usefully noticeable impress of environment on leaf size for any but the most exact quantitative work. Yet WEBB (1959) finds it necessary, in an essentially qualitative physiognomic-structural classification, to divide further one of RAUNKIAER's classes in two, better to express the correlation between Australian rainforest types and the climate and site. Any intensive analysis of correlation between physiognomic-structural characters and the environment will probably show up, in particular cases, other significant characters that were not previously considered or the necessity to make finer distinctions in the expression scale of those characters already used. This, then, should be the aim of particular investigations. It is not to be expected that the characters and expressional classes used in distinguishing vegetation forms on a world scale can demark categories that will best show up the correlation of form with environment in any one region. Especially so, since the number of characters and expressional states must be few if the classification is to be practical, and as a result, the categories will each cover a great deal of variation. Therefore, in the system presented here the criteria used are those that seem most useful in distinguishing vegetation forms in themselves, by their *above-ground aspect*, without reference to any environmental correlation that can be made with these forms. The fact is, in some cases, correlation will be easily made using the forms as is, while in other cases more minute differences (including those in the optional list in the Appendix) will have to be considered.

FOSBERG's system recognizes swamp forests as a separate form coordinate with forests on drained substrates, and submerged or floating meadows as separate forms coordinate with grass fields and herb fields on drained soils. It seems to me that these are differences in *landscape*, not in vegetation in itself. If the criterion is adaptation of the vegetation to withstand periodic or sustained flooding in the one case, or adaptation to a completely aquatic existence in the other, this brings in environmental considerations of a specific kind as to the habitat: a swamp or a body of water. On the other hand, FOSBERG makes no difference in his system between rainforests and other closed forests (on drained soil), although a rainforest, like any other vegetation, also is adapted to the particular environment it encounters. In the system presented here, all environmental considerations are rigidly excluded in the classification and terminology. The *examples* given under certain vegetation forms in the main list, however, are grouped according to environment to call attention to the different conditions under which the same vegetation form can occur.

The categories and names of FOSBERG's system, or of the one presented here, are meant to be used where relatively rough categories and short names are wanted for vegetation stands anywhere in the world so that all the categories can be directly compared, one with the other, *in one system*, at one time. The categories and their names may be used on herbarium labels as part of the habitat information, as units in large-scale vegetation mapping, as units for correlation with topography or other measurements or estimates of ecological factors, or as short descriptions or terms for the vegetational aspects of the environment in animal studies, geographical studies, land use surveys, military description of terrain, etc.

Any system based on structure, growth form and vegetative periodicity that is meant to be applicable to the whole world and that has few enough categories so that their names can be reasonably short, will inevitably be too gross to analyze in the best possible way the vegetation of any one region, or the variation in any one large-scale floristic-geographic vegetation type. For example, the 19 physiognomic types that WEBB (1959) distinguishes in the Australian rainforests fall here into only 8 categories. Local *ad hoc* classifications naturally distinguish local vegetation types better (even if only visible aspect is concerned and not ecology) since they are specially made up to deal with the limited number of types in a region. On the other hand, any local classification will break down in some aspects when used elsewhere, particularly in a different continent or climatic zone.

Within any one region the different vegetation forms can be distinguished by aspect, or useful arbitrary portions of a continuum can be demarked, on a non-floristic basis, based on certain fine details, such as branching pattern, bark color, bark texture, leaf form, leaf size and color, thorniness, gnarledness, presence of lianas and vascular and non-vascular epiphytes, etc., as well as on the large-scale aspects of height, spacing, and deciduousness. But the exact characteristics and expressional states that best distinguish the vegetation forms in one region would not necessarily distinguish them in the best possible way in another region. Therefore, a world system, if it is not to be impossibly cumbersome, must sacrifice some of its ability to make fine distinctions. When studying one region the student should use or make up an *ad hoc* system that best fits the local case. But if it were a regular practice also to correlate in a table the local categories with those of some world system, in time the vegetation forms of the world could be directly compared. It is often difficult for another person to classify someone else's categories according to a different system; some needed information is almost always lacking. The same person who makes up or uses a local system should relate his categories and examples to some standard world system.

The basic idea of the system presented here is to use only those criteria that can be evaluated rapidly when looking at a stand of vegetation. It should not normally be necessary to go up to any individual plant to see or feel fine detail. Only two to four states of each criterion are used except for growth forms, where several dozen are used, although no more than a few will be encountered in any one stand in sufficient numbers to make a strong individual impress. Therefore, there are relatively few total categories, considering the distinctions that can be made. One of the valuable features is that the vegetation form can usually be told from aerial photographs and from ground photographs as well as from the actual stand.

Since the system is meant to be one that can be rapidly and practically applied, it is necessary to decide first how much attention should be given to a stand to be able to classify it. Should the system be such that it can be applied with only one visit to the stand, or are several required during the year? If one visit suffices, may the visit be made at any season or only at a particular season? One visit cannot supply in all cases the information needed to decide on the deciduousness or seasonality of the stand, or even the struc-

tural category to which it belongs when the ground layer must be taken into consideration in determining the latter. Deciduousness can vary within the dry season, for instance, as well as between dry and wet. The herbaceous layer must be seen regularly throughout the year to decide if it is evergreen, seasonal or ephemeral, where this must be taken into consideration. Since vegetative periodicity is so fundamental in any account of the aspect of vegetation, as well as a basic characteristic for any study of the correlation of vegetation with environment, this periodicity must be made one of the criteria used in defining the form. The final categories given in the main list are therefore based on knowledge of the stand throughout the year or (in semi-dry regions with erratic rainfall) over a period of a few years. However, there are many out-of-the-way places where little is known about the vegetation cover and in which it might be impossible for the observer to remain during a whole year. It would be convenient to be able to apply the present system to stands seen only once, and this at any time of year. In the discussion of the criteria, alternative ways of expression will be given where necessary to enable this to be done.

The criteria used in the present classification are:

1. Height and cover of the principal layers. These give the basic *structural categories*.

2. Growth forms of individuals in the principal layers, including only those growth forms that are important in producing the general aspect.

3. Vegetative periodicity (deciduousness and seasonality) of the principal layers.

These three criteria alone sufficiently express the visual impact that a stand of vegetation has in its grosser aspects.

The "principal layers" of a stand are those used in determining its structural category, as indicated below.

STRUCTURAL CATEGORIES

The groups based on height and cover form the basic framework of the system; the other criteria form qualifications of them. Twenty six structural categories are recognized. These are defined in Table I and are repeated in the main list of vegetation forms under the same Roman numbers. Table II shows the relation of the categories to each other in terms of cover and height.

Principles used in determining the structural categories. In any structural classification of a stand* of vegetation a number of "layers" are distinguished. If too many layers are taken into consideration the number of structural categories becomes so large that it would be difficult to assign a stand quickly to any one category. On the other hand, if too few layers are considered the categories are too rough and do not sufficiently distinguish stands whose aspects are quite different. For the degree of precision desired in the present

* A stand is considered to be an area of a fraction of a hectare to several hectares, which is adjudged to be more or less physiognomically homogenous (according to the rough criteria adopted here) within each of the principal layers, i.e., those used in classifying the stand. It is not necessary to be homogenous in layers not used in classifying the stand.

classification, five layers, distinguished as follows, are the most convenient number, although, as will be seen, only three are used in classifying any one stand.

(1) The layer of tall and medium-tall trees (over 7 m), called here simply the tree layer.

(2) The layer of low trees (3-7 m tall).

(3) The layer of scrub elements of any height. (Scrub heights may be distinguished using the optional criteria in the Appendix.)

(4) The tall ground layer (1 m or more).

(5) The low or shortplant ground layer (less than 1 m tall).

The "ground layer" usually includes only the herbaceous elements but there are exceptions as explained below.

In determining the structural categories of the present system it is not necessary to consider the height and spacing of all the layers but only those that determine the *contour of the upper surface of the vegetation*. Structure beneath this surface is disregarded. When the tallest layer is closed, this is the only principal layer. When the tallest layer is open or sparse the next lower layer is also taken into consideration so that both these are principal layers. When all the tree and scrub elements together form a sparse cover or are absent, the ground layer is taken into consideration, so that all layers are principal layers. Thus, a closed-canopy arboreal stand is a "forest"; in a forest the scrub and herbaceous layers are not here considered for it is not the intention of the system to classify the internal structure of forests.

Distinguishing the layers. The present system depends on the human scale, that is, the major distinctions in aspect that a person on the ground would make, looking at the stand. This means that differences in height are more important at levels near to the eye-level of a person on the ground. A difference between 1 meter above ground level and 4 meters above ground level makes a considerable difference in aspect, while the same difference of 3 meters at a higher level (such as would be, for example, the difference in aspect to a person on the ground between a forest 15 m tall and one 18 m tall) has a much smaller influence.

Therefore, the tree layer is divided at 7 meters into "low trees" and "trees".* The difference between medium-tall and tall trees is made an optional criterion.

The difference between the tree layer and the scrub layer unfortunately cannot be a simple case of height. In FOSBERG's system the distinction is one of height, below 5 m being scrub, and above, trees. FOSBERG has informed me (*in litt.*) that his choice of 5 m was arbitrary, and that he would have chosen some other height, such as 6 m, if this would be more in conformity with other systems. However, my objection is that to distinguish forest and scrub simply on a height basis, whatever height is chosen, would cause too many forest-looking stands to be called "scrub" and too many stands of definite scrub aspect to be called "forest". Thus, a stand of definite tree-like plants, say

* I realize that this is not the best terminology from the logical point of view, since "low trees" are part of the class of trees in general. But in view of the other words that will have to be added to form the complete name of the vegetation form, this terminology seems the simplest that can be made and in use does not seem to cause confusion.

4 m tall, would have to be considered "scrub" in FOSBERG's system as it stands, while a *Nypa* palm brake (a stand of acaulescent palms whose leaves rise vertically) that happens to be over 5 m tall, as many are, would have to be called a "forest", since these leaves could hardly be considered as part of a "ground" layer. Since I feel that the application of these names to these stands would not be a happy one, and that it is better to call the 4 m tree stand a type of "forest" and a palm brake of any height a "scrub", the distinction I propose between the tree layer and the scrub layer is somewhat more complicated.

First, it is necessary to decide between what is a "tree" and what is a "scrub element", as individuals. For forestry, one kind of definition may be desirable, for a classification of growth forms in general, another definition may be better. Our purpose is simply to distinguish the two kinds of growth forms most quickly and conveniently, in any vegetation type, and without forcing the meaning of the words as commonly used, so that the *layers* they represent may be distinguished at a glance.

Briefly, a "scrub element" is any plant that is not either a tree nor a definite herbaceous plant. Thus, besides the usual conception of "shrubs", other "scrub elements" include any of the larger, hard or succulent, persistent plants that have a "scrubby" appearance, such as acaulescent forms of *Agave* and cacti, trunkless large terrestrial bromeliads, etc. Since these lack trunks they are in no danger of being confused with trees no matter how large they are. This leaves two other classes of branching pattern in which there is a transition between what might be called "shrubs" and what would be called "trees". For our purpose it is necessary to draw a line somewhere.

Case 1. *Pachycaul plants*. Single-trunked unbranched plants with a single tuft of leaves, such as trunked species of *Espeletia*, *Puya*, *Lobelia*, *Senecio*, *Agave*, *Yucca*, *Pachypodium*, *Xanthorrhoea*, palms, cycads, etc. (monocaul). Some of these monocaul species branch at the base to form clumps but do not branch above. Some individuals may branch exceptionally once or a few times above the base. Other species of the same groups regularly branch several (but not many) times above the base (oligocaul). All these pachycaul plants represent the "sword trees" of CORNER (1966) but also include forms like the giant senecios and *Pachypodium* whose leaves either do not have the size or the shape to be called "sword leaves". We may include here also forms such as *Dendrosicyos* which have a very thick main trunk and at the end of it branch several to many times, but with very short and thin branches that form a continuous or interrupted crown that is altogether insignificant in the total contour of the individual.

A convenient arbitrary height to divide these forms into a lower "scrub" element and a taller "tree" is 3 meters.

Case 2. *Non-pachycaul*, several to many-branched woody plants. These oligocaul and polycaul forms are the non-herbaceous plants most commonly met with. Here the distinction between trees and shrubs, as it is actually applied implicitly by most people, is based upon a set of criteria, and relationships between them, that is extremely complicated. To say that a tree has a single trunk and a shrub several woody stems from ground level by no means settles the case.

What seem to enter as factors in calling a branched woody plant a tree or a shrub are: (1) total height, (2) whether the branching is excurrent or deliquescent, (3) presence of a single main trunk and the height of this in relation to its thickness, (4) absolute thickness of the main trunk when the bole (unbranched part of trunk) is short, or thickness of the principal ascending branches ("split trunks") when the central main trunk is very short or absent, (5) height of lower edge of the leafy part of the crown.

(1) Even if all other criteria are shrublike, we would probably call a self-sustaining, woody, leaf-bearing plant a tree and not a shrub if it was over, say, 7 m tall, even if it had several trunks, while no matter how much like a tree it is in form, we would call the plant a shrub if it were less than, say, 1 1/2 m tall. Between these more or less vague upper and lower limits some persons might call the plant a tree and others a shrub depending on the other criteria.

(2) When erect and definitely excurrent, such as most conifers, even when the crown reaches the ground, we would probably not call the plant a shrub if it was over a certain height. For our purposes such plants are trees if 3 m tall or more, and scrub elements if lower.

(3) The presence of a single main trunk is, of course, one of the most important criteria in calling a plant a tree, but when the trunk is very thin or very short its value is less.

(4) The thicker the main trunk is, the less tall the bole must be for us to call the plant a tree. For instance, we are likely to call a plant a tree and not a shrub, particularly if it is over 3 m tall, when it has a single main trunk 30 cm in diameter, even if the "bole" is only 30 cm tall and then branches giving rise to thick boughs. The more erect these boughs are and the higher the lower level of the crown the more treelike in aspect it will be.

(5) When the crown occupies only the upper part of the plant, and particularly when its lower edge is above eye-level, we are likely to call the plant a tree when (a) there is only one trunk, even a thin one, or (b) if there are several main erect stems, these are thick. On the other hand, if the crown reaches low to the ground, then, even with the stems as indicated, we are more likely to call it a shrub (unless it is both tall and strongly excurrent).

From this discussion we see that the criteria that make us call a plant a tree or a shrub are many and with complicated interrelationships. To attempt to set up an arbitrary dividing line for all possible cases would be almost impossible, although a few guidelines may be given for consideration so that there would not be too much variation in usage.

A. Self-sustaining woody plants over 7 m tall, whether with one or many trunks, should be considered trees.

B. All self-sustaining woody plants less than 3 m tall should be considered shrubs and therefore scrub elements.

C. Self-sustaining woody plants between 3 and 7 m tall should be called trees if (1) they have an unbranched more or less erect trunk at least 1 1/2 m long and 15 cm or more in diameter, or (2) they have an unbranched more or less erect trunk at least 1 1/2 m long when the diameter is less than 15 cm, or (3) when the single trunk is less than 15 cm diameter and somewhat shorter

than 1 1/2 m long, the plant may be called a tree if the main branches after the trunk splits are few and ascending and the lower edge of the crown is above eye-level, or (4) when there are several trunks from ground level of at least 15 cm diameter and the lower edge of the crown is above eye-level. In all other cases, self-sustaining woody plants between 3 and 7 m tall should be considered shrubs and therefore scrub elements.

The division between trees and shrubs given here was decided on after observing a large number of individual plants in the field and in photographs and trying to judge in each case whether it would be more correct to call the plant a shrub or a tree, assuming this distinction into only two classes had to be made.

As scrub elements intergrade into trees at one end, they also intergrade into herbaceous elements at the other end. Thus, the larger terrestrial bromeliads, *Yucca*, *Espeletia*, *Eryngium*, succulents such as cacti, *Agave*, *Alôe*, etc., appear "scrubby", but the smaller sizes of these forms intergrade into herbs in aspect if not in morphology. Less extreme succulent forms such as *Portulaca* and *Sueda*, and extremely succulent but small forms such as *Salicornia* and the stone plants of the Karroo Desert of South Africa, which do not present a "scrubby" appearance, are included here in the herbaceous or "ground" layer. The exact border between scrub and herbs must also be left to the observer. As will be seen when the "ground" layer is defined, even definite scrub elements, when they are low and blend in aspect with herbaceous elements, are considered as part of the ground layer.

It would be useful to have been able to separate height classes in the scrub layer in making the primary structural categories. FOSBERG, for instance, makes a distinction between "scrub" and "dwarf scrub". However, if one is going to separate out dwarf scrub, there is no reason not to distinguish low, medium-tall and tall scrub also. After several attempts it was seen that this would increase the number of structural categories beyond all practical limits, as well as require very long expressions to distinguish them. Suggested height classes for scrub are given as optional criteria in the Appendix. Where the scrub layer must be taken into consideration in determining the structural category and is more or less uniform in height, these height classes should be appended even if no other optional criteria are used, and will help in making distinctions that are important at the human scale, at the cost of merely adding one extra word to the name.

Continuity of the vegetation cover is the second basic criterion used in forming the structural groups, and I have essentially followed FOSBERG in his delimitation of four classes, "closed", "open", "sparse" and "absent". These are defined at the beginning of the list of structural categories below. In terms of percent cover the dividing points are 60% and 10% (and of course 0% for absence). More than 60% cover is "closed", between 60% and 10% cover (and including these values) is "open", less than 10% is "sparse" or "scattered". I have arrived at these values by calculating the area covered by circles scattered over a surface. If the circles are of equal size and touch (whether their centers form a square or a triangular lattice makes no difference) they cover 78.5% of the surface. If the circles are of uneven sizes and

touch as much as possible, the area covered is slightly more.* However, to allow for the occasional gaps that are often present in what is commonly considered "closed" vegetation, I have placed its dividing point to "open", at 60%. This is also the point that DANSEREAU uses to separate "forest" from "woodland". At this point the perimeters are separated by an average distance of $1/6$ their average diameters.

If equal size circles are separated by a distance of twice their diameter they cover 8.7% of the surface. If the circles are of various sizes and separated by a distance of twice their average diameters, the area covered is slightly more. For instance, with circles of two sizes, one twice the diameter of the other, the area covered is 9.7%. Thus 10% is a good rough dividing point to separate "open" from "sparse".

It should be noted that discontinuity in cover may be due to any environmental reason at all, such as lack of sufficient rain, lack of sufficient soil even where rain is plentiful, instability of the substrate (moving sand dunes, landslides, water currents carrying away submerged, floating or emergent plants, etc.), high levels of salts in the substrate, overgrazing, past fires, cutting, erosion, animal stamping, etc.

Cover of the herbaceous elements may vary during the year. In regions of dry climate with irregular rainfall, the seasonal maximum cover may vary from year to year. Where it is necessary to consider the herbaceous layer in determining the structural category this creates a problem. When the behavior of the herbaceous component is known throughout the year, use the definition as given. When a single visit is made and no other information is known or can be inferred about the density and height of the herbaceous elements at other times of the year, *use the present aspect* and give the date or season in parentheses at the end of the expression. This will imply that the aspect is of that date but may be different at another time. The change in herbaceous cover through the year means, for example, that an arboreal sparse scrub (which by definition has a sparse or absent ground layer for more than nine months of the year, whether alive or dead on the stem) may have an ephemerally denser ground layer during the rainy season (a density of "closed" or "open"), and so will appear like a savanna. If a single visit is made at this time, one can only say that the stand is a savanna. A "tallplant field", which by definition has a ground layer that reaches 1 m tall at some period during the year, may be seen by the observer in a single visit when this layer is less than 1 m tall, and so must be called a "shortplant field". A "tallplant field" or a "shortplant field", which by definition has a ground layer with 10% or more cover at some time during the year, may be seen during a part of the year when the cover is only "sparse", and for a single visit must be called a "sparse field". It should always be made clear in the context of any report on vegetation where the herbaceous elements must be considered, whether the classification of the stand is based on knowledge of only one visit or on inferred or observed year-round behavior.

As few structural categories as possible have been distinguished in the

* FOSBERG's definition of "closed" is perimeters touching or overlapping, which means a cover of over 75%.

present system. Those chosen and the definitions of their limits can perhaps be justified by the following considerations.

A. Stands with *closed* cover of trees or scrub or mixture of the two. Where the tree and scrub elements together form a closed cover (more than 60%), or one of these does by itself, several types are possible: (1) a single more or less even canopy, (2) two or more definitely separated layers in which the upper one is open or sparse and the lower one forms a closed cover filling in the interstices left by the upper, (3) a tree-plus-scrub cover so irregular in height that neither one nor more distinct layers can be said to exist. These three cases are now considered further.

(1) A stand in which trees form a single closed canopy is generally called a "forest", and when trees are absent and scrub elements form a closed layer can be called "closed scrub". A difficulty appears when a closed, more or less even, single canopy is made up of a mixture of low trees plus tall scrub elements which are as tall as the trees. In this case, if the scrub elements are few and the aspect is still essentially one of trees, the stand is a "low forest", but when the canopy scrub elements are numerous or conspicuous enough appreciably to influence the aspect, the stand is a "closed scrub".

(2) With two or more distinct layers, if the upper layer is sparse (less than 10% cover) and scattered, but definitely projecting above a closed lower layer, the tall plants are called "emergents". If the upper layer is open (10-60% cover of trees more than 3 m tall) and definitely projecting above the scrub layer, the stand is called "open forest with closed scrub" or "open low forest with closed scrub", as the case may be. If the upper layer is open and the lower is closed, but *both* are of scrub elements, the stand is "closed scrub" or "uneven closed scrub". Using the optional scrub height distinctions, subdivisions can be made in this case if desired, i.e., "open tall scrub with closed low scrub", etc.

(3) A stand with a cover of very irregular level presents a special case. When the irregular layer is made up all of trees, we generally do not let this influence our terminology; the stand is a "forest". However, when the irregular surface of vegetation occurs at a lower level so that part of this surface is scrub and part is trees, we must be careful of the term used. If all individuals, low and tall, were scrub elements, the stand would be "closed scrub", or if desired, "uneven closed scrub". But when the scrub elements vary in height and there are also trees here and there in the stand (the trees perhaps with irregular heights also), we cannot call the stand strictly either a "forest" or a "closed scrub". So a special category was distinguished for this case, "uneven closed trees and scrub" and "uneven closed low trees and scrub". The tree cover here may be under or over 10% but definitely must be substantially less than the scrub cover in order to give this type of form.

(4) In distinguishing "forest" and "low forest" a division is made in the tree layer based on height. In distinguishing "tallfield" from "shortfield" a height division is made in the ground layer. However, the division here is not based (as it usually is in physiognomic systems) on a single height. Thus, as individuals, a "low tree" is 3-7 m tall, while a "tree" (i.e., a medium-tall or tall tree) is above 7 m. But if we made 7 m the height division between the "low tree" layer and the "tree" layer, where should we place a stand that

is essentially 6 m tall but with one or a few trees reaching 8 or 9 meters as slightly and gradually projecting crowns forming part of what is essentially a single-layered canopy? One or a few trees slightly surpassing the limit does not change the whole stand from "low forest" to "forest" (i.e., to "medium-tall forest" in this case). But as more trees surpass the 7 m height limit we have less and less the aspect of a "low forest". Therefore, a limit has to be set beyond which the category changes. It is set here at 10%. If 10% or more absolute crown cover is over 7 m tall (i.e., 10% or more of the ground is covered by portions of crowns over 7 m tall), the stand is a "forest"; if less than 10% is so covered it is a "low forest". This is because the part that exceeds a certain height may be relatively small, well less than 50%, and still have a strong influence on the aspect.

The same reasoning is used when crowns over 7 m tall conspicuously project above a general canopy less than 7 m tall. If the crowns over 7 m tall form less than 10% absolute cover, the stand is "low forest with emergents"; if the tall crowns form 10% or more absolute cover, the stand is "forest". Examples in the field and profile drawings showed that 10% was the best rough dividing point.

Exactly the same reasoning holds in the division between "tallfield" and "shortfield" in respect to the herbaceous cover. The general division is at 1 m. Herbs over 1 m tall may be present but if they sum up to less than 10% absolute cover (whether conspicuously emergent or not) the stand is a "shortfield". If they sum up to 10% or more absolute cover the stand is a "tallfield".

B. Stands with an *open* cover of trees or scrub or mixture of the two. When the trees and scrub elements *together* form an open cover (10-60%), the unevenness of the surface of this cover or the presence or absence of emergents makes less difference in aspect since the cover is broken anyway. In this case emergents would have to rise particularly high above the general surface to be noticeable as emergents. What is most important here is the total height of the layer and whether the cover is made up all of trees (with scrub elements absent or negligible), all of scrub elements, or of a mixture of the two in which both are conspicuous. Hence, only four types are considered, "woodland", "low woodland", "tree and scrub woodland", and "open scrub". In "tree and scrub woodland", since the tree component must be slight in order that the scrub component can share prominence with it, no difference is made between trees under or over 7 m tall.

C. Stands with a *sparse* cover of trees or scrub or mixture of the two. When the tree or scrub layer is closed, any other layers that may occur below the upper closed layer do not in general influence popular terminology for the stand as a whole. Where grazing is important, sometimes "grassy forests" are distinguished from forests in which there are no closed grassy layers, but they are both forests. When the tree or scrub layers are open, the ground layer becomes more important in the total aspect. However, in order not to have too many categories, I have considered the ground layer as a criterion only when the tree plus scrub layer taken together is sparse or absent (i.e., less than 10% cover). Two degrees of density of the ground layer are then considered, closed or open on one hand (10% or more cover), and sparse or absent on the other (less than 10% cover). With the denser ground layer a

difference is made between a layer up to 1 m tall and a layer 1 m or more tall. When the ground layer is sparse, no difference in height is considered. As for the upper layer, when sparse trees and scrub are present, tree height is not considered, merely whether they are all trees (with scrub absent or negligible in aspect compared to the trees), or all scrub (with trees absent or negligible), or a mixture in which both trees and scrub elements are conspicuous. Thus we have 6 types of savanna (ground cover closed or open, i.e., 10% or more, for more than 3 months of the year) and 3 types of sparse woodland or sparse scrub (ground cover sparse or absent for more than 9 months of the year).

D. Stands with trees and scrub *absent*, or, if some low and dwarf scrub elements are present, these are hidden by taller herbs or blended in with herbs of the same height so that they do not stand out as distinct elements. In either of these cases we have three types. (1) "Tallplant field", a closed or open ground layer with enough plants 1 m or more tall for them strongly to influence the aspect, say 10% or more absolute cover for the tall plants. Scrub elements, if present, must not stand out as such. (2) "Shortplant field", a closed or open ground cover essentially less than 1 m tall. Scrub elements, if present, must not stand out as such. (3) "Sparse field", scattered ground vegetation of any height. In the latter case only definitely herbaceous plants will usually be considered as forming the ground layer. Since the individuals are scattered, any appreciable quantity of definitely scrub-looking plants, even if low or dwarf, would stand out as such, and the stand would have to be classified as a type of scrub. Height of the plants is not considered in "sparse field", since, being sparse, the proportion of the herbaceous cover that is one height or another is less important and more difficult to estimate.

Terminology of the categories. A desirable terminology is that which is as short as possible and which without special explanation beforehand will enable a reader to visualize with more or less accuracy the structure referred to. Therefore, it is necessary to choose such words as will, as far as possible, not give false impressions because of their usual non-technical meanings as to cover, height etc., nor bring in ideas of the type of environment to be encountered. Therefore, I do not use such terms as "desert" as an adjective, as FOSBERG does, to give the idea of "sparse". Although the original etymological definition means a region not or very sparsely inhabited, today it will mean to almost anyone a region of very little rainfall and with little or no plant growth for this reason, or perhaps also, a region in which the ground has been artificially eroded and the plant cover has disappeared.

(1) "Scrub" is used instead of "shrub" as the name of a layer and a category, since it may then be used whether the individuals in it be tree-like and less than 3 m tall, shrubs of any height, forms difficult to decide as one or the other, other scrubby elements that could not really be called "shrubs", or mixtures of these. It is felt that the usefulness of having a single term (and this seems to be the only one available in English) outweighs the slight objection that the word "scrub" (or particularly the adjective "scrubby") could be taken to imply that the woody vegetation of this layer must be somewhat gnarled, twisted or jagged. It may be, of course, but no such implication is intended here.

It should be noted that "scrub" is used both for a particular layer in a stand and for certain types of whole stands. There is no reason why confusion should result from this double use.

The word "thicket", which refers to a whole structural category and not to a layer, might have been used here. It has not been for it covers only part of the meaning of "scrub", referring to a medium-tall or tall closed scrub. For "thicket" does not usually apply to a scrub that one can see over the top of, that is, to one less than about 1 1/2 m tall. Also, although it might be possible to talk of an "open thicket" for the taller scrubs with as little as 30-40% woody cover, the word would not be applicable to stands more open than this. A "sparse thicket" is a contradiction in terms. Since "scrub" with qualifying adjectives can be used for all heights and densities, this word provides a more uniform terminology.

(2) I do not use "steppe" as an adjective or noun since this term is used in so many senses that it is almost meaningless. As a noun, FOSBERG uses "steppe" to refer to a grassland or herbfield with open but not sparse cover. As an adjective ("steppe forest", etc.) he uses it to refer to an open scrub or open forest whose lower woody and ground layers are not closed. Certainly, the average layman, botanist or geographer, hearing the word, would not necessarily think of these exact structural forms. To some, "steppe" is a bunch grassland, whether closed or open, to others a grassland with scattered low shrubs, the grass cover closed or open, etc. The original Russian meaning seems to cover various cases: continuous tall prairie, bunch grassland with low carpet grasses seasonally filling the interstices, bunch grasslands with open bare soil between the clumps, etc. Certainly, the idea of an open but not sparse cover is not necessarily implied. In order not to multiply inordinately the number of categories I have not made the distinction between closed and open ground layers a primary criterion. This distinction is one of the optional criteria to be used if desired.

(3) The word "savanna" also has been used in several senses. One is purely ecological, referring to a large-scale set of conditions, generally in the tropics, that make for large areas of grass or herbland (with or without scattered woody plants or intermixed patches of scrub) rather than mesophytic forest, marsh or desert. In this case, savanna can include several major structural forms for the same the region: pure grassland, pure structural savanna in the sense used in this paper, and also included dense scrub, woodland and "forest", when the woody plants of these last three are basically of savanna rather than true mesophytic forest species. It should be noted that very different ecological conditions can cause savanna in this ecological sense to appear in different regions.

In the purely structural sense, one usage is certainly predominant: a grassland (or broadleaf herb-covered area) with scattered trees or shrubs or small scattered groves of these. There is an implication that a herbaceous layer is definitely present, whether closed or open, but on the other hand not particularly sparse, and that this herbaceous layer lasts a considerable portion of the year (alive or dry) or is permanent, not that is merely ephemeral. In this paper, "savanna" will be used in this purely structural sense only.

As stated, in many systems and usages (whether ecological-structural or stated to be purely structural), the word "savanna" is used for pure grassland as well as for pure structural savanna (BEARD, 1953; TROCHAIN, 1957; AZEVEDO, 1962), qualifying adjectives being used to distinguish the forms without woody growth, with trees, with shrubs, etc. This seems unnecessary when structure is the consideration since the word "grassland" or its physiognomic equivalents ("prairie", "meadow", "pradaria", "campo limpo", etc.) in English and other languages are available. To add to the confusion, the same authors who use "savanna" to include pure grassland often do not use this word for *all* pure grass- or herb-covered areas, the difference in usage in the same system being unexplained or depending on non-physiognomic criteria like altitude or other environmental factors (TROCHAIN, 1957).

(4) "Woodland" here is restricted to that portion of its meaning that implies that trees are present, not just scrub.* I have used the word according to its usual American connotation of an *open* tree stand, rather than according to its British connotation of either a closed *or* open tree stand, since "forest" already refers to a closed stand. "Woodland" is used rather than "open forest" since the latter expression, besides being two words instead of one, is vague as to whether it is the canopy that is open, or whether the undergrowth is open under a closed tree canopy. In the expression in which "open forest" is used here, "open forest with closed scrub", the situation is clear since the lower layer is specifically mentioned separately. The expression "open forest", even when "open" refers to the canopy, implies nothing about the density of the lower scrub layer. Since a distinction in category is made here when the tree canopy is open, between the case where the scrub layer is closed on one hand, and where it is open, sparse, or absent on the other hand, different terms are needed. In its American sense, at least, "woodland" almost always implies a rather open or absent scrub layer under an open tree canopy. It does not, however, imply anything about the density of the herbaceous layer.

When there are scattered trees and shrubs with cover less than 10% we use "savanna" when a herbaceous layer is more or less definitely present. But when the herbaceous layer is absent or very sparse and becomes denser if at all only ephemerally, we cannot call it a savanna. This condition is generally called "desert woodland", "desert scrub", etc. Since I do not wish to use the word "desert" because of its ecological connotations, it is necessary to employ the word "woodland" again for the arboreal aspect, but this time as "sparse woodland". There does not seem to be any other purely structural term available.

(5) For vegetation forms lacking woody or otherwise persistent scrubby plants, or in which low or dwarf scrub element are present but hidden by or blended in aspect with more numerous herbs, I have used only three categories. To have considered separately two grades of height and four grades of density for the ground layer, as well as all possible mixtures, would have

* Thus, "scrub woodland" is not used. "Tree and scrub woodland" is used for cases where the tree and scrub layers have equal prominence. In the complete expressions for the vegetation forms, where growth form and periodicity terms enter, a variation in word order is sometimes necessary in order to preserve the idea that the stand is a tree-and-scrub woodland and not basically a scrub-woodland with other elements mixed in. Thus, "deciduous broadleaf tree and scrub woodland", but "woodland of tree cactus and deciduous broadleaf scrub".

made an extremely large number of categories, multiplied even more when we consider later on the difference between the various herbaceous growth forms and their seasonality. In a formula method all these combinations may be taken into consideration, but it would be too cumbersome to use here.

A problem arises in respect to those non-arboreal stands where a very thick growth of grasses or forbs overtops and completely hides the whole scrub layer, at least during the favorable season. This probably does not occur where the scrub layer is closed but it may where it is open or sparse. In the sparse case, where the herbaceous plants must be taken into consideration in deciding the structural category, there are two alternatives. If the stand is being visited only once, and this when the scrub is hidden, it is a "tallplant field" or "shortplant field", as the case may be. If behavior throughout the year is the basis of the classification and the herbaceous plants are seasonal so that they die down and reveal the scrub elements during part of the year, then one can use, for instance, "dwarf scrub seasonal tallgrass savanna (seasonally with tallgrass field aspect)", etc. When the overtopping grass or herbs are evergreen and permanently hide the scattered low or dwarf scrub elements through the year, or the scrub elements are the same height as the herbs and grass and visible if searched for, but do not immediately stand out as distinct scrub elements, then one should use "evergreen tallgrass field", "evergreen tallherb field", etc., as the case may be. Thus a "dwarf scrub tallgrass savanna", for instance, would only be distinguished when, at least during part of the year, the tallgrass cover is sufficiently open so that the dwarf scrub elements can be made out separately.

There are cases where it is difficult to tell at a glance whether a low or dwarf broadleaf scrub is present, with true shrubs and subshrubs dominant, or whether a tallherb field or shorterb field is present with *only* herbaceous plants, or whether there is a mixture of the two. I have seen such cases on unburnt waste ground in the city of São Paulo and on cut-over but unburnt areas with low secondary growth in the southern Brazil mountains. The climate is sufficiently humid throughout the year so that the aspect remains the same all the time. The leaves and branches of the shrubs and subshrubs are not distinguishable from those of the herbs of the same height that they are mixed with (when both are present) so as to be able to distinguish the woody from the non-woody plants at a glance. One would have to investigate individual plants to know what form they are. This type of community grades at one end into stands of definite closed shrubbery in the secondary succession to forest and at the other end into pure closed stands of broadleaf herbs of waste ground and abandoned fields and pastures. For a quick determination it seems best to make an arbitrary distinction on some other ground in this case. One can call the stand a shortplant or tallplant field if the layer is not higher than the height to which pure herbfields can grow in such situations, 1 m, for instance or 1 1/2 m. If higher than this, then it will almost certainly be composed mostly of real scrub and should be called "closed scrub".

A place must be found for small scale mosaic vegetation made up of regularly or randomly dispersed clumps of one physiognomic form set in a

matrix of another form. An example is the inner "restinga" (sandy coastal plain) vegetation at Cabo Frio, State of Rio de Janeiro, Brazil, described in DAU (1960). Here, clumps of dense scrub several meters in diameter and with sharp borders are separated from each other by open ground of about the same area covered with a herbaceous ground cover. The scrub clumps here are small enough that they should not be considered a separate vegetation from the open ground, but the mosaic of the two together must be considered as one form. The best disposition is therefore to call it "open clumped scrub". Clumped scrub is not a primary structural category but enters as a variation analogous to growth form. (See examples 96, 109 and 114 in the main list.) Mosaic vegetation is to be distinguished from larger scale differences that are almost always due to *large-scale* habitat differences, such as gallery forest in grassland or savanna, or clumps of forest scattered over an open region in slight depressions or along water courses.

With these introductory remarks we may pass to the preliminary definitions of terms used in defining the structural categories.

Trees

(1) Self-sustaining woody or semi-woody plants (monocaul, oligocaul or polycaul) when (a) 3 m tall or over with single trunks (see previous discussion); (b) 3 m tall or over with a few thick trunks from ground level and lower edge of crown above eye-level (1.5-1.8 m roughly) (see previous discussion); (c) over 7 m tall, with several thick trunks and crown reaching down to any level,

(2) Giant arboriform herbs like the banana "tree", with definite pseudotrunk, when 3 m tall or over,

(3) Bamboo clumps over 3 m tall.

Scrub elements

(1) All woody and semi-woody plants less than 3 m tall, including tree-like forms, shrubs, ground lianas, *Welwitschia*, trunked monocaul plants, etc.,

(2) Definite shrubs (see previous discussion) even if over 3 m tall,

(3) Non-woody plants or plants with non-woody above-ground parts, of any growth form or size, that are definitely not herbaceous and leafy and that are not tree-like, such as trunkless *Agave* and cactoids, acaulescent palms and cycads, the larger, stiffer-leaved bromeliads, etc.

Visible scrub

That not hidden at the moment by thick herbaceous vegetation nor blended in with its aspect.

Emergents

Isolated, scattered trees or scrub elements that project a large part of themselves above a closed canopy (or above the general level of the high points of an uneven closed canopy).

Herbaceous layer

Graminoids, forbs, very low non-leafy succulents, bryophytes, lichens, seaweeds, and visably evident thickish masses of microscopic filamentous

algae or Characeae (but not plankton, thin *Pleurococcus* or *Trentepohlia* films, etc.)

Degree of cover

Proportion of a particular area of ground, substrate or water surface covered by a layer of plants, considered at the greatest horizontal perimeter level of each plant in the layer:

closed: more than 60% cover; the perimeters in this case, on the average, overlap, touch, or are very slightly separated (*i.e.*, by an average distance of not more than $1/6$ the average perimeter diameter).

open: 10-60% cover; the perimeters in this case are separated, on the average, from very slightly, up to twice the average perimeter diameter.

sparse or *scattered*: less than 10% cover; the perimeters separated by an average distance of more than twice the average perimeter diameter.

In all uses of "closed", "open" and "sparse" or "scattered" in this paper, the definitions are as given here.

NOTE: For cases in which it is necessary to consider the herbaceous elements in order to determine the structural category, the definitions are based on year-round behavior. For short single visits see discussion after the list and in the Introduction.

Table I. List of Structural Categories

I. FOREST WITH EMERGENTS: forest (as defined next), but with isolated, scattered, conspicuously emergent trees projecting above the canopy, the emergents having less than 10% total cover.

II. FOREST: closed even or uneven tree canopy, that part exceeding 7 m in height having 10% or more absolute cover; no definite emergents above this layer.

III. LOW FOREST WITH EMERGENTS: low forest (as defined next), but with isolated, scattered, conspicuously emergent trees or tall scrub elements projecting above a closed canopy, the emergents having less than 10% cover.

IV. LOW FOREST: closed even or uneven tree canopy between 3-7 m tall, that part, if any, exceeding 7 m doing so as part of the general canopy cover and having less than 10% cover; no definite emergents present of any height. If tall scrub elements are present (such as shrubs over 3 m tall, for instance), *making up part of the canopy*, the total aspect should be more forest-like than scrub-like.

V. OPEN FOREST WITH CLOSED SCRUB: surface of plant cover at two more or less distinct levels, (1) the upper level an open tree layer, that part exceeding 7 m in height having 10% or more absolute cover, (2) the lower level a closed scrub filling in the spaces between the *trunks* of the trees of the upper layer (when the tree crowns are totally above the scrub layer) or

between the *crowns* of the trees of the upper layer (when the crowns extend down into the scrub layer).

VI. OPEN LOW FOREST WITH CLOSED SCRUB: surface of plant cover at two more or less distinct levels, (1) the upper level an open tree layer between 3-7 m tall, that part, if any, exceeding 7 m having less than 10% absolute cover, (2) the lower level a closed scrub filling in the spaces between the *trunks* of the trees of the upper level (when the tree crowns are totally above the scrub layer) or between the *crowns* of the trees of the upper layer (when the crowns extend down into the scrub layer).

VII. UNEVEN CLOSED TREES AND SCRUB: trees and scrub elements together forming a closed cover whose upper surface is so uneven that neither one nor more distinct separate levels of cover can be distinguished; the lower levels of the cover consisting of scrub and the taller levels of trees over 7 m tall. (For this category to occur it is necessary that the part covered by scrub be substantially more than the part covered by trees.)

VIII. UNEVEN CLOSED LOW TREES AND SCRUB: trees and scrub elements together forming a closed cover whose upper surface is so uneven that neither one nor more distinct separate levels of cover can be distinguished; the lower levels of the cover consisting of scrub and the taller levels of trees 3-7 m tall (taller trees absent or negligible). (For this category to occur it is necessary that the part covered by scrub be substantially more than the part covered by trees.)

IX. CLOSED SCRUB WITH EMERGENTS: closed scrub (as defined next) but with scattered, isolated, conspicuously emergent trees or taller scrub elements, the emergents having less than 10% total cover.

X. CLOSED SCRUB: closed even or uneven canopy of visible scrub elements; no definite emergents. Generally less than 3 m tall, but if of definitely shrubby aspect may be taller. In the case of scrubs over 3 m tall, if low trees are also present, *making up part of the canopy*, the total aspect should look more scrub-like than forest-like.

XI. WOODLAND: open even or uneven tree layer, the average height of the upper surface of the canopy exceeding 7 m in height; scrub layer open, sparse or absent. Trees definitely dominant in total aspect. Herbaceous layer present or not.

XII. LOW WOODLAND: open even or uneven tree layer between 3-7 m tall, trees exceeding 7 m in height absent or negligible; scrub layer open, sparse or absent. Trees definitely dominant in total aspect. Herbaceous layer present or not.

XIII. TREE AND SCRUB WOODLAND: open even or uneven layer of more or less equally conspicuous trees and scrub elements, the scrub elements lower than, the same height as, or possibly taller than the trees. Herbaceous layer present or not.

XIV. OPEN SCRUB: open even or uneven layer of scrub elements. Trees absent or negligible. Herbaceous layer present or not. Generally, an

open scrub is less than 3 m tall, but if of definitely shrubby aspect may be taller. In the case of open scrubs over 3 m tall, if low trees are also present, the aspect should look more scrublike than definitely arboreal.

XV. ARBOREAL TALL SAVANNA: scattered trees; scrub elements absent or negligible; herbaceous layer present with 10% or more cover for three months or more during the year (as organized plant bodies, whether alive or dead on the stem), and with 10% or more absolute herbaceous cover reaching 1 m or more in height at some time during the year.

XVI. ARBOREAL SHORT SAVANNA: scattered trees; scrub elements absent or negligible; herbaceous layer present with 10% or more cover for three months or more during the year (whether alive or dead on the stem), all of it always less than 1 m tall or, if part reaches or surpasses 1 m at any time of the year, that part has absolute cover of less than 10%.

XVII. TREE AND SCRUB TALL SAVANNA: trees and scrub elements together scattered and more or less equally conspicuous; herbaceous layer as in XV.

XVIII. TREE AND SCRUB SHORT SAVANNA: trees and scrub elements together scattered and more or less equally conspicuous; herbaceous layer as in XVI.

XIX. SCRUB TALL SAVANNA: trees absent or negligible; scrub elements scattered; herbaceous layer as in XV.

XX. SCRUB SHORT SAVANNA: trees absent or negligible; scrub elements scattered; herbaceous layer as in XVI.

XXI. SPARSE WOODLAND: trees scattered; scrub elements absent or negligible; herbaceous layer sparse or absent (*i.e.*, less than 10% cover) for more than nine months of the year. (For less than three months the herbaceous layer may be denser.)

XXII. TREE AND SCRUB SPARSE WOODLAND: trees and scrub elements together scattered and more or less equally conspicuous; herbaceous layer sparse or absent for more than nine months of the year. (For less than three months the herbaceous layer may be denser.)

XXIII. SPARSE SCRUB: trees absent or negligible; scrub elements scattered; herbaceous layer sparse or absent for more than nine months of the year. (For less than three months the herbaceous layer may be denser.)

XXIV. TALLPLANT FIELD: trees and visible scrub elements absent or negligible; ground layer closed or open (*i.e.*, 10% or more cover) all year or at least for some period during the year, with 10% or more absolute cover reaching 1 m or more in height at some period during the year.

XXV. SHORTPLANT FIELD: trees and visible scrub elements absent or negligible; ground layer closed or open all year or at least for some period during the year, all of it always less than 1 m tall or, if part reaches or surpasses 1 m at any time during the year, that part has an absolute cover of less than 10%.

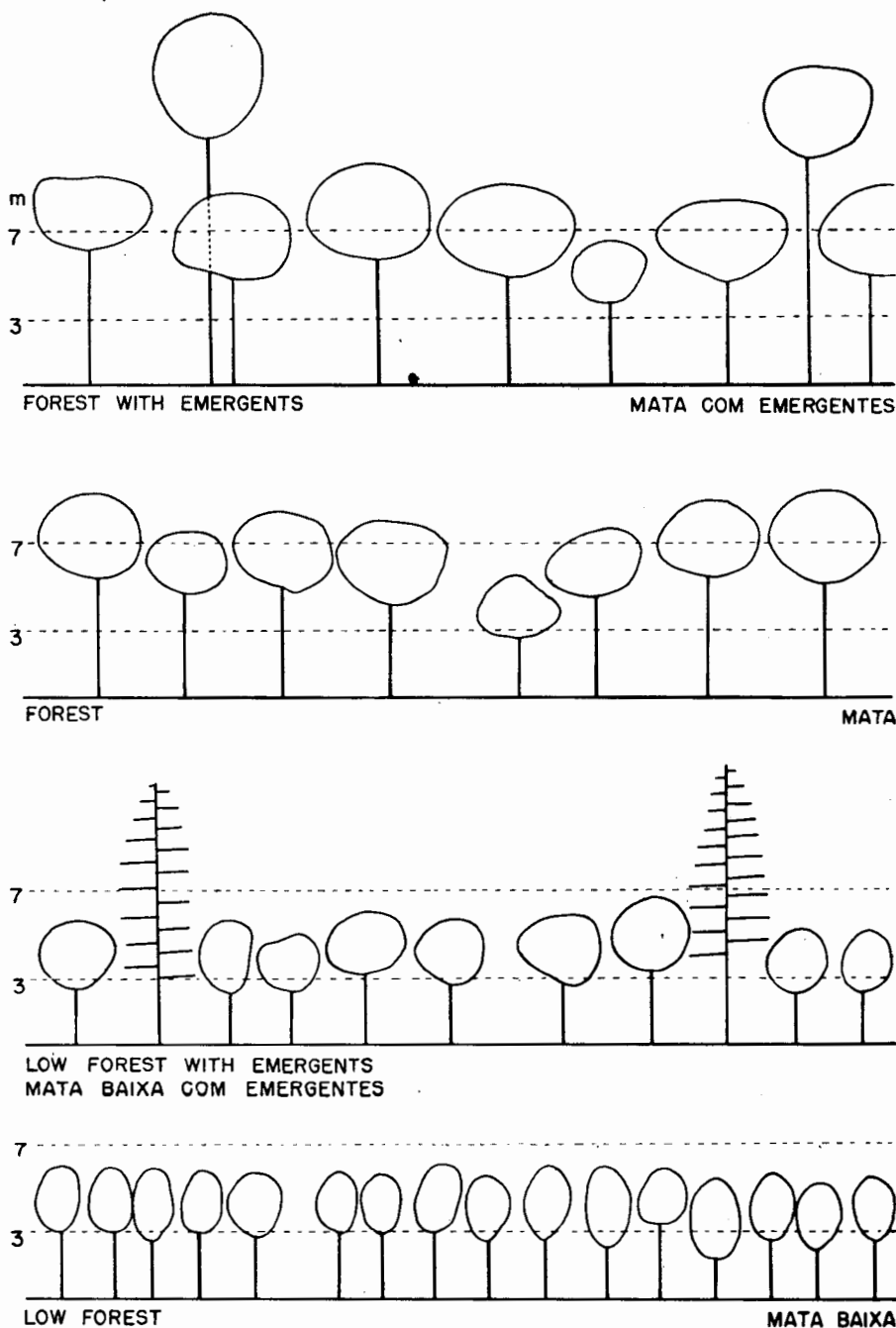


FIG. 1

m

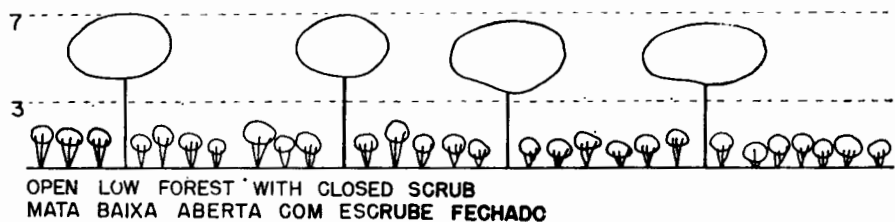
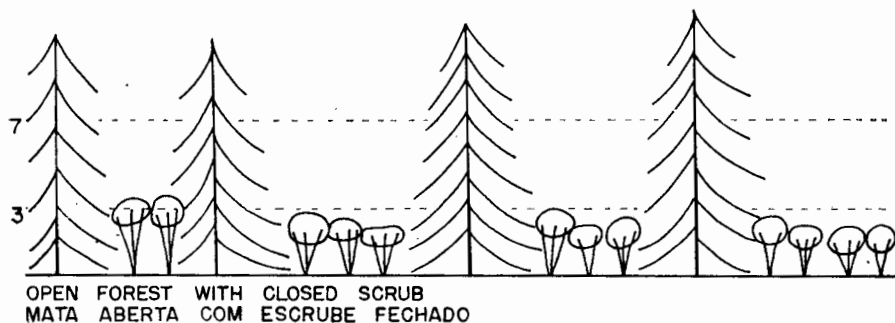
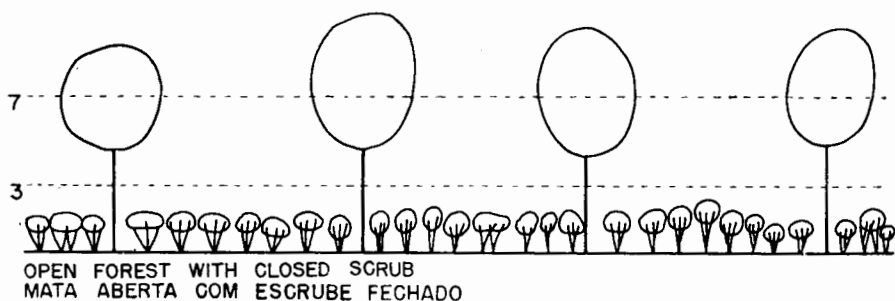
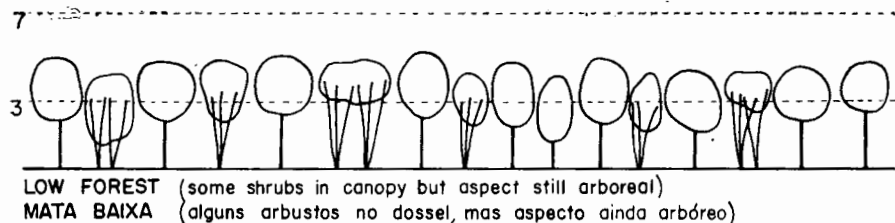


FIG. 2

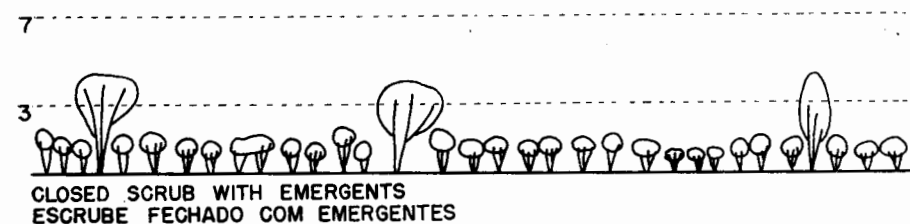
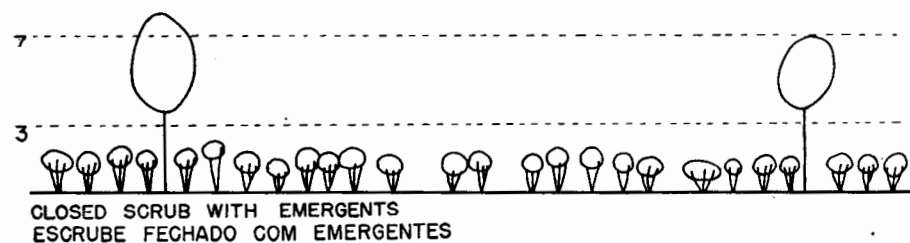
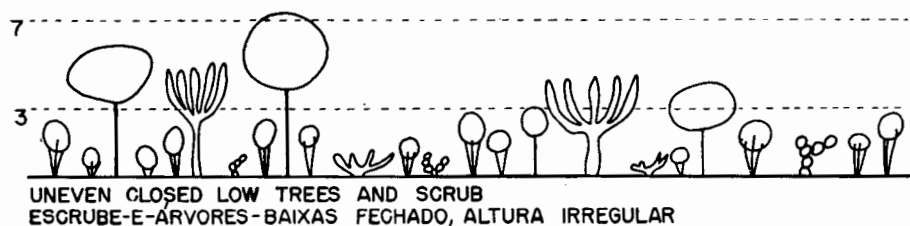
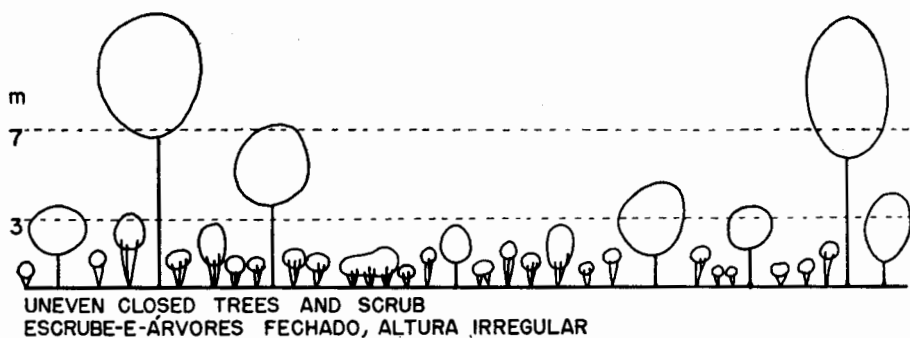


FIG. 3

m

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3

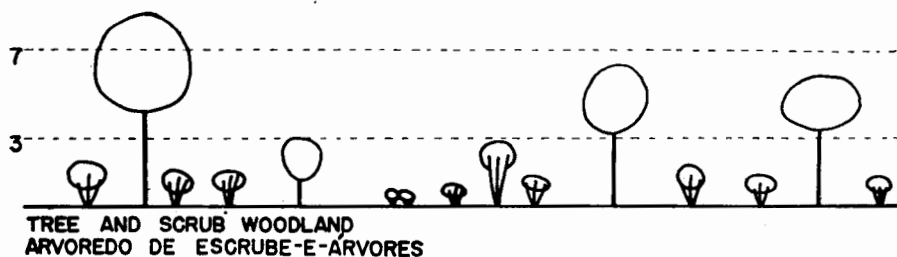
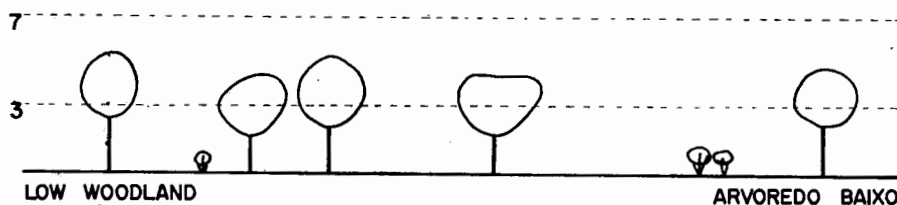
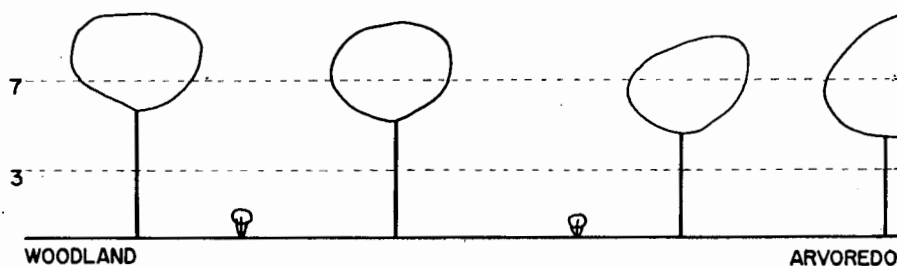
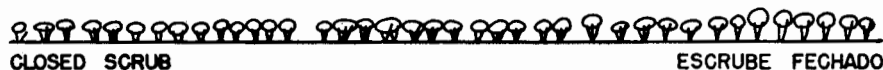
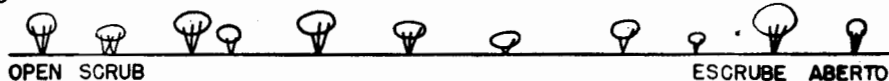


FIG. 4

m

7

3



ARBOREAL TALL SAVANNA
SAVANA ALTI-HERBÁCEA ARBÓREA

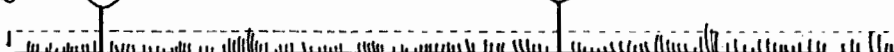
7

3



7

3



ARBOREAL SHORT SAVANNA
SAVANA CURTI-HERBÁCEA ARBÓREA

7

3



TREE AND SCRUB TALL SAVANNA
SAVANA ALTI-HERBÁCEA COM ESCRUBE-E-ÁRVORES

FIG. 5

m

7

3

1

TREE AND SCRUB SHORT SAVANNA
SAVANA CURTI-HERBÁCEA COM ESCRUBE-E-ÁRVORES

3

1

SCRUB TALL SAVANNA
SAVANA ALTI-HERBÁCEA COM ESCRUBE

3

1

SCRUB SHORT SAVANNA
SAVANA CURTI-HERBÁCEA COM ESCRUBE

3

1

LOW SCRUB TALLGRASS SAVANNA (TALLGRASS FIELD ASPECT)
SAVANA ALTI-GRAMINOSA COM ESCRUBE BAIXO (ASPECTO DE CAMPO
ALTI-GRAMINOSO)

7

3

SPARSE WOODLAND

ARVOREDO ESPARSO

FIG. 6

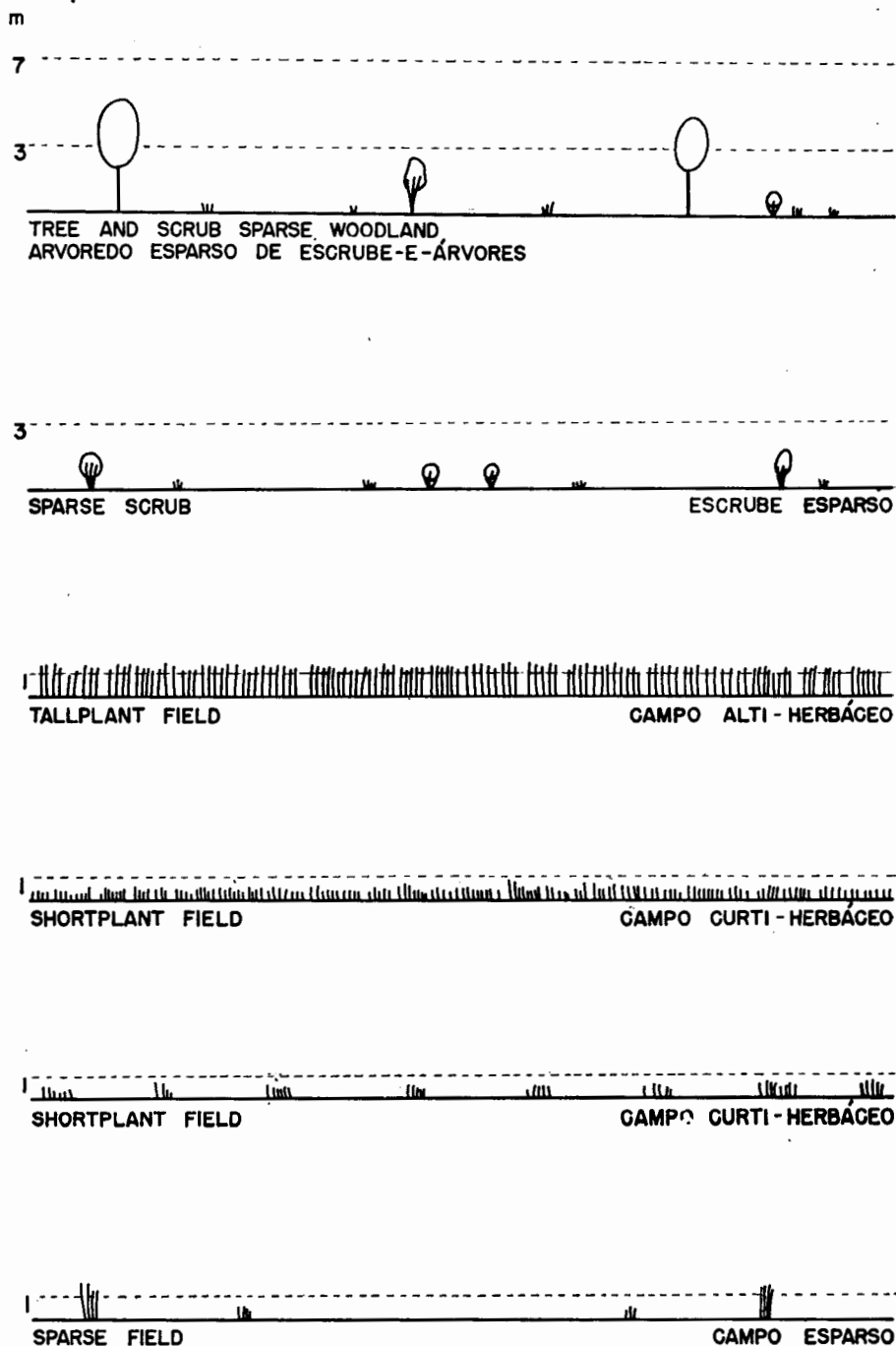


FIG. 7

Table II. Relation of structural categories to height and cover.

The same proportion of trees and scrub elements of various heights as yields a particular category when forming a closed cover, will give the category shown at the same level in the columns to the right when the cover is open or sparse.

			Trees and scrub elements together forming a layer that is								
			OPEN (10-60% cover)		SPARSE (less than 10% cover)		ABSENT (or with low & dwarf scrub elements present but hidden by or blended in aspect with more frequent herbs)				
			in XIII and XIV. In XI and XII the tree layer is open, and, separately, the scrub layer is open, sparse or absent		Herbaceous cover 10% or more for 3 months or more during the year		Herbaceous cover less than 10% for more than 9 mo. during the year	Cover 10% or more for some period during the year		Cover less than 10% at all times	
CLOSED (more than 60% cover)					Herbaceous cover essentially 1 m tall or more	Herbaceous cover essentially less than 1 m tall		Cover essentially 1 m tall or more		Cover essentially less than 1 m tall	
tree cover proportion	more than 60%	I. Forest with emergents	XI. Woodland		XV. Arboreal tall savanna	XVI. Arboreal short savanna	XXI. Sparse woodland	XXIV. Tallplant field	XXV. Shortplant field	XXVI. Sparse field	
		II. Forest									
		III. Low forest with emergents	XII. Low woodland								
		IV. Low forest									
	10-60%	V. Open forest with closed scrub	XIII. Tree and scrub woodland		XVII. Tree and scrub tall savanna	XVIII. Tree and scrub short savanna	XXII. Tree and scrub sparse woodland				
		VI. Open low forest with closed scrub									
		VII. Uneven closed trees and scrub									
		VIII. Uneven closed low trees and scrub									
	absent or less than 10%	IX. Closed scrub with emergents	XIV. Open scrub	XIX. Scrub tall savanna	XX. Scrub short savanna	XXIII. Sparse scrub					
	absent	X. Closed scrub									

XXVI. SPARSE FIELD: trees and visible scrub elements absent or negligible; ground (herbaceous) layer sparse, of any height. Ground layer never denser than sparse at any time of year.

Differences between the structural categories in Fosberg's system and the one presented here. There is little relationship between the categories of the two systems. In general, every category of FOSBERG covers parts of several of mine. FOSBERG's principal criterion is cover of the vegetation as a whole, including all its layers together, but he defines his categories by means of the cover of each layer separately. This method does not take into consideration that the cover of any one layer may or may not fill in the interstices of another, so that two open layers, for instance, may produce closed or open vegetation as a whole depending on how much one lies directly under the other. For stands with some layer or other completely closed, there is no problem. For savanna vegetation this discrepancy may not be too serious. For woodlands (Fosberg's "open forest") the difficulty is always present. If trees cover 40% of the ground, for instance, and shrubs plus herbaceous vegetation cover 40% also (the 60% not covered by shrubs or herbs being bare soil), the total cover can vary from 80%, if all the shrubs plus herbs are in the space between the tree crowns, and so be called "closed", to 40%, if all the shrubs plus herbs are under the tree crowns, and so be called "open". For such cases, whether the vegetation as a whole is closed or open can be solved on the ground only by noting whether a vertical line over a sufficiently large number of points scattered through the stand intercepts some layer or other of vegetation or no layer — a rather tedious process, and one that cannot be done by looking at the stand but only by walking through it and taking counts.

The categories of the system presented here are primarily for ground observers, and particular categories can vary in their total cover depending on degree of overlap among the several layers. But even so, the categories can almost always be read from aerial photographs and so be used as units in mapping. I have tried to make the categories exhaustive so that any possible combination of height, spacing and overlap will fall into one or another. Several such possible combinations, I have noticed, would not fall into any of FOSBERG's categories as defined.

For stands 3 m tall or more, I have given weight to whether the appearance as whole is tree-like or scrub-like, instead of automatically making the difference between forest and scrub a case of height simply. An open stand of many-stemmed diffuse shrubs, even if tall (as in some Australian mallee bush) should really be called "open scrub" and not "woodland" in the sense as used here of "open forest". Growth form as well as height and spacing must influence our terminology for the structure of the stand as a whole.

CRITERIA NOT USED

Before discussing the other two criteria used in the present classification (growth form and vegetative periodicity) it is necessary to explain why leaf type, size, and sclerophylly are not used. These characters are almost always employed in physiognomic-structural systems.

Leaf type. What is usually meant by "needle-leaf" plants, for instance, are the needle- and awl-leaf conifers and not angiosperms that have leaves of the same form, such as ericoids and many desert trees and shrubs. Besides this, "needle-leaf" is also applied to excurrent conifers that, properly speaking, have flat, rather wide leaves (*Araucaria angustifolia*, etc.) and also to those that have appressed scale-like leaves (*Chamaecyparis*, *Thuja*, mature *Juniperus*, etc.) Actually, the strikingly different visual effect that the "needle-leaf" conifers give to vegetation derives as much or more from other characteristics of these plants than from their leaf shape, viz., from their (1) excurrent growth form* (in distinction to their usually deliquescent neighbors), (2) often darker foliage, (3) evergreen nature (except for *Larix*, etc.), their neighbors usually being deciduous. This different visual effect, of course, must be taken into consideration in any classification in which dominant growth form is a criterion and the question is what adjective to apply to it. In the North Temperate Zone, where conifers are vegetationally important or dominant, the word "conifer" or "coniferous" is usually used. On a world scale this is not exact since conifers exist with other aspects, such as relatively broadleaf deliquescent *Podocarpus*, completely broadleaf *Gnetum*, spartoid *Ephedra*, and the unique *Welwitschia*. In an extended sense the cycads are "conifers" also since they bear cones. The choice then settles down to using either "needle-leaf", or "conifer" with all its weakness, or making up a new term. I cannot think of any new term which would be short, free of all difficulties and likely to be accepted. I believe that "conifer" has fewer objections because, although as used here it does not include *all* conifers, at least it does not include plants not meant to be included, such as "needle-leaf" would. "Conifer" as a growth form then will refer to gymnosperms with true needle-, awl- or scale-like leaves (or, if the leaves are somewhat broad, the growth form is definitely excurrent, as in *Araucaria angustifolia*), and will be coordinate to the other growth forms listed, and not represent merely a leaf type.

Leaf size. FOSBERG divides his broadleaf plants into three classes, megaphyllous, mesophyllous and microphyllous, the size limits dividing the three being different for trees, shrubs and herbs. (These terms are not equivalent to the Raunkiaerian terms.) I do not make this distinction since at a slight distance from the stand microphyll leaves usually do not make much visual difference from mesophyll leaves, while on the other hand, the larger mesophyll leaves ("macrophyll" in RAUNKIAER's sense) can make a visual difference which is not expressed in the system. When dominant, megaphyll leaves do, of course, make an obvious difference, but plants with megaphyll leaves are almost always of such distinctive growth form that they are considered under that criterion.

"Microphyll" is a useful term for *leaf* characterization and for making quantitative correlations between vegetation stands and the environment, but it is not very useful for distinguishing vegetation stands by eye and at a glance. "Microphyll" applied to trees, for instance, lumps together such very different-looking non-coniferous forms as *Tamarix* with its appressed scale

* There are exceptions, such as *Pinus pinea*, which just for this reason loses a large part of the distinctive visual effect that conifers have in vegetation. This species should be referred to as "deliquescent conifer" when used as a growth form in a stand of vegetation.

leaves, and many kinds of leguminous trees with large, lacy, spreading, once or several times pinnately-compound leaves with tiny leaflets. These are certainly as different looking from each other and in their impress on the vegetation as either is from an ordinary mesophyll tree. On the other hand, I wish to subsume all these three forms under the "normal" form, for the difference between them are less than the rough categories of the present system are meant to express.

Although leaf size is not used as a criterion, the *examples* given under certain vegetation forms in the main list are grouped by leaf size classes.

Sclerophylly. I do not use sclerophylly as a criterion in the system presented here. Important as it may be ecologically, it does not particularly strike the eye when looking at a stand of vegetation from a distance sufficient to take in the stand as a whole. Also, even though the various expressions of height and spacing, for instance, intergrade, we can choose definite numerical limits for the classes based on these criteria. But there are no definite units with which to measure sclerophylly short of engineering tests on leaf bending. Also, a degree of sclerophylly that would make us call a small leaf sclerophyll might not make us call a large leaf sclerophyll. Is a banana leaf sclerophyll or not? Also, leaves and leaflets can be stiff (when wilted) lengthwise but not crosswise, as in many graminoids and palm leaflets. Therefore, even the small-scale differences in aspect that sclerophylly might cause by its influence in preserving certain leaf orientations is lessened when "sclerophyll" leaves can roll up.

Stiffness of a wilted leaf may be due to silica content, fiber or sclereid content, a thick cutinized layer, or various mixtures of these. A large proportion of rainforest trees have coriaceous leaves, but rainforest is not usually considered a sclerophyll vegetation. Many temperate stands dominated by Ericaceae or by certain species of *Quercus* have a preponderance of stiff leaves, but these are not always classed as sclerophyll types. Within needle-leaf conifers there is every degree of stiffness from the soft needles of *Larix* to the only slightly stiffer needles of the white pines (*P. strobus*, etc.) to stiffer types like *P. rigida*, etc. Where does one draw the line between sclerophyll and non-sclerophyll needle-leaves? The frequent characterization of conifers in general as "narrow sclerophyll" is not happy.

In the Brazilian "cerrado" vegetation every gradation exists within a single stand between definitely non-sclerophyll and definitely sclerophyll leaves. Without actually making tree and shrub counts and testing on some scale the sclerophylly of each species, and so forming an index of sclerophylly for the stand, it is impossible to say whether the stand is predominantly sclerophyll or non-sclerophyll. One cannot tell in a rapid examination.

Although the difference between completely non-sclerophyll and extremely sclerophyll stands is obvious enough, the intermediate cases are sufficiently numerous and so difficult to assess, as well as not making much difference in the general aspect, that for our purposes it may be left out of consideration. When obvious, it may be mentioned as an optional criterion. For correlation with environment, the degree and type of sclerophylly can always be given in special studies without being required to consider it for the type of classification given here.

GROWTH FORMS

Growth forms are distinguished here only when they produce a strikingly different effect, *en masse*, or when two or more well-differentiated types are mixed. There are a large number of growth forms of woody plants and these may be characterized in a critical analysis according to particular combinations of several criteria: total contour, branching pattern, leaf size, leaf shape and consistency, leaf insertion (massed at one point, massed at a few separate points, solidly covering an unbranched or few-branched stem, distributed in general at and near the ends of numerous branches, etc.), thickness of trunk and twigs in relation to total size, density and shape of crown, etc. Besides these there exist the more numerous forms of herbaceous plants, as well as scrubby non-woody forms like untrunked *Agave* and cacti which cannot exactly be called "shrubs". However roughly or finely we delimit growth form classes, the limits will be arbitrary, the problem being analogous to delimiting species phenetically.

Growth form classes, once delimited, may be *named* (1) according to the taxonomic group whose species are of that form (palm, bromeliad, cactus, etc.), (2) according to the name of a characteristic plant of the class with the suffix "oid", when the class contains forms not all in the same taxonomic group ("palmoid" for tree palms, tree cycads, tree ferns, banana trees, etc., "cactoid" for cactus and cactus-like *Euphorbia* and *Asclepiadaceae*, "agavoid" for *Agave*, *Alöe*, etc.)*, (3) according to the morphological criteria used in delimiting the class. In the latter case, some classes can have short names, like "liana", "sword tree", "rosette plant", etc., but to be more explicit and distinctive the name would have to be very long. Date and coconut palms and tree cycads, for instance, would have to be called something like "monocaul unipinnate-megasclerophyll monotuft-crowned trees", certain species of unbranched single-trunked *Espeletia* and giant senecios would be "monocaul macro-orthophyll monotuft-crowned trees" (or shrubs), slightly-branched yucca and *Dracaena* would be "oligocaul ensiform-sclerophyll oligotuft-crowned trees", *Ulmus americana* and most humid forest trees would be "deliquescent meso-orthophyll trees", *Picea*, *Abies* and most conifers called "excurrent aciculifoliar trees" (in the last two cases the "polycaul" being understood), etc. Obviously, expressions such as these are too long to be fitted into our system.

In the classification given here the growth form classes are made very roughly, and for forms other than the "normal" form the English or Latin floristic name is used, along with a few short descriptive names. The intention is to give names that characterize the principal growth forms of a stand, not its floristic composition.

In the list below, certain of the forms are subsumed under a descriptive group name like "rosette-tree", "succulent scrub", etc. This is for cases where

* "Palmiform", "cactiform", "agaviform", etc., are alternate terms. It should be noted that not all palms are included in "palm" or "palmoid" when these are used to represent growth form and not taxonomic affinity; the climbing palms such as rattans and *Desmoncus* are excluded.

either the name of the plant is not known to the observer, or is an unfamiliar restricted genus or species, or there is a mixture of several forms of the same type in the stand so that it would be too long to mention them all individually. These group names are useful in practice although they cannot be made mutually exclusive and still be short. *Agave*, for instance, is both a rosette plant and a succulent. If *Agave* were conspicuously present in a Mexican desert with cacti but without other rosette plants like yucca, one could say "open succulent scrub", while if it were present without conspicuous cacti but with yucca, one could say "open rosette scrub", in those cases where one did not wish to use the individual names. Cacti and yucca alone would form a "cactus and yucca open scrub" or, more generally, a "succulent and rosette plant open scrub".

Other group names could be made. "Tree-palmoid" and "scrub-palmoid" could be used to include palms, cycads, tree-ferns, *Musa*, *Ravenala*, etc., "cecropioid" could include *Cecropia* and *Musanga*, "vellozioid" could include *Vellozia*, *Barbacena*, *Nolina*, etc. However, the number of these types that are dominant in vegetation are much more limited than succulents or rosette-plants, so it might be better to use the individual names, especially where an individual name refers to a widespread and important growth form such as "palm". The descriptive class names, however, are available, and more may be added than just those given in the list below.

Once we take out the strikingly unusual growth forms we are left with a residue of "normal" forms with the following characteristics:

- (1) polycaul (many-branched), excurrent or deliquescent, if a tree; if a shrub, may be many- or few-branched;
- (2) broadleaf and micro-, meso- or macrophyll, very rarely megaphyll and if so (as in *Artocarpus*) then not monocaul,
- (3) if coniferous then relatively broadleaf and deliquescent (like *Podocarpus*).

It is evident that the "normal" form covers a large range of variation but that the different forms of it grade into each other and even the extremes are not too different. There is no single term or short phrase that encompasses all this variety, even if we were to make up a new term. This means that any term used will be inexact or even wrong in some cases. Yet if we add discriminating adjectives the terms will become very long and, in any case, we will be making a distinction finer than the system is meant to express. I cannot see any way out of this difficulty. It is one that arises for any physiognomic-structural system on a world basis that means to use relatively short terms as names for stands, and not minute descriptions.

After much consideration of the possibilities, I have chosen "broadleaf" as the best single term to refer to the "normal" range of forms. It is true that palms and banana trees are also "broadleaf", but it must be understood that the term refers to those growth forms not already distinguished as separate types in the system. This is one of those cases where a term is not automatically and completely self-explanatory. On the other hand, using a word like "mesophyll" (which would distinguish almost any of the "normal" forms from palms and from needle-leaf and scale-leaf plants) would necessitate the distinction of microphyll broadleaf forms and possibly of macrophyll forms also.

It would then be necessary to distinguish all these cases and their mixtures, although the differences are not so striking and all fall within the "normal" range as here constituted. "Broadleaf" must be understood to refer to the growth form of the whole plant; it is not a leaf type only.

There are not so many growth forms, as roughly defined here, that are dominant in vegetation, that they cannot all be recognized immediately without special botanical training after having once seen examples of them in the field or in illustrations. I doubt if more than 60 are required for the world and less than this for any one continent. Rarely are more than three conspicuous in any one stand. As seen from the names in Table III, most of the forms are distinguished and named (in some language or other) by people in general. It is interesting that almost all the forms other than the "normal" are evergreen so that this does not have to be specifically mentioned. If deciduous, this should be mentioned: deciduous bamboo, deciduous conifer, etc.

The growth forms used are listed in Table III. From this list the degree of difference necessary to be considered a separate form can be appreciated better than by any definition. The list does not claim to be complete. Other forms equally different from all those listed can be added where necessary. The classification of growth forms is a subject inherently difficult and is the weakest part of any vegetation form system, but since growth form is so important in the total physiognomy of a stand, even an imperfect rough characterization is better than none.

Table III. List of Growth Forms Dominant in Vegetation

TREES (3 m tall or more)

broadleaf (i.e., "normal" trees)

conifer

casuarina

tree-palmoid, such as:

palm

cycad

tree-fern

Musa (or banana tree)

Ravenala

tree-cactoid, such as:

tree-cactus

tree-euphorbia (trunked)

tree-ecropioid, such as:

Cecropia

Musanga

bamboo

pachycaul (in expressions such as "pachycaul woodland"; used for trunked pachycaul forms 3 m tall or more, not accounted for separately in this list, or for single forms whose name is not known)

rosette-tree (for trunked forms 3 m tall or more; used for mixtures, or for single forms whose name is not known)

examples of rosette-tree:

Pandanus (or pandan)

yucca (or joshua tree)

Dracaena (or dragon tree)

Xanthorrhoea (or grass tree)

Espeletia

Puya

tree-lobelia

tree-senecio

etc.

SCRUB ELEMENTS

broadleaf (i.e., "normal" shrubs)

conifer (less than 3 m tall)

casuarina (less than 3 m tall)

aphyllous (i.e., spartoid, switch-plant)

cushion (polster, including cushion-cactus; when 15 cm tall or more)

liana (only when dominant in stand over all other growth forms)

bamboo (less than 3 m tall)

giant-aroid (large forms with trunks)

Welwitschia

scrub-palmoid, such as:

palm (acaulescent of any height, or tree-palms less than 3 m tall)

cycad (acaulescent of any height, or tree forms less than 3 m tall)

tree-fern (with trunk, less than 3 m tall)

Musa (or banana tree; less than 3 m tall)

Ravenala (acaulescent of any height, or trunked and less than 3 m tall)

scrub-cecropioid, such as:

Cecropia (less than 3 m tall)

Musanga (less than 3 m tall)

scrub-cactoid, such as:

cactus (large acaulescent forms of any height when conspicuous, or trunked forms less than 3 m tall)

cactoid-euphorbia

stapelioid

succulent scrub (for mixtures of several succulent forms, or for single form whose name is not known)

rosette scrub (or where suitable, "rosette-plant"; the *larger* acaulescent forms *where separately conspicuous*, as well as trunked forms less than 3 m tall; used for a mixture of several rosette types or one type whose name is not known; where the following types are recognized use the individual names):

yucca

bromeliad

Eryngium

nolina

vellozia

scrub-lobelia

scrub-senecio

Sansevieria

agave

alôe

Espeletia

etc.

pachycaul scrub (such as in "pachycaul tree and scrub woodland", "pachycaul scrub savanna, etc.; for individuals and layers less than 3 m tall; used for pachycaul elements not accounted for in this list or whose names are not known)

HERBACEOUS ELEMENTS

grass (i.e., graminoid in general, may be individual stems, carpet-forming or in clumps, but not with strongly conspicuous and separate tall stools when seen)

tussock grass (graminoids with permanent and strongly conspicuous separate stools when seen (single visits) or that appear as such sometime during the year)

herb (i. e., broad-leaved herbs or "forbs", including rosette herbs, small succulent forms like *Portulaca*, *Salicornia*, Crassulaceae, Karroo stone plants, etc.)

cushion-herb (polsters up to 15 cm tall)

fern (acaulescent)

lichen (in pure stand or dominant or codominant in aspect)

moss (in pure stand or dominant or codominant in aspect)

seaweed*

alga mat (thickish masses of filamentous algae)

There is a problem of seasonal aspect dominance in herbaceous vegetation. When a grassland, meadow, marsh, or the ground layer in a savanna has an aspect dominance of broad-leaved herbs for one part of the year and is predominantly graminoid for another part, it would seem most natural to include the stand under that aspect which is visually dominant during the greater part of the year (the herbaceous plants either alive, or dead on the stem but still visible as organized plant bodies). When two or more aspects approach equal representation during the year it will be necessary to use a longer expression like "field with seasonally successive herb and graminoid aspects", etc. (The expression "grass and herb field" is already pre-empted for stands where the two aspects are spatially mixed and equally prominent at the *same* time.) For single visits, naturally, one names the stand after the aspect present at the time.

DECIDUOUSNESS AND SEASONALITY

This is an aspect of the vegetation itself, although like all other characteristics it is caused by the environment directly or because of its previous

* Seaweed stands are included in this system only when the seaweed is dense or otherwise dominant in aspect. The shallower underwater stands usually contain conspicuous fixed animals such as corals, sponges, anemones, etc., which give character to the aspect, but these are not included in the present system.

influence in the selection and evolutionary development of the component species.

I. Terms for a single visit

A. Terms for degree of leaf retention of trees and scrub elements of the principal layer or layers as found at any one time. The date or season should be placed in parentheses at the end. In semi-dry regions of fluctuating climate, also give the year.

1. *All-green*: less than 10% leafless or essentially leafless at the moment. The color of the foliage does not matter as long as it is in its fully alive and functioning state.

2. *Semi-green*: 10-90% leafless at the moment (that is, 10-90% of the leaves should have fallen or, if still attached, should be dead and dry, or yellowed).

3. *Deciduous*: more than 90% leafless at the moment.

The point here is that if we see a forest, woodland, scrub, or the woody component of a savanna that is all-green at the moment, even if we see it during some part of the dry season, we cannot tell (without previous knowledge of the stand or its type) whether it might not be semideciduous or fully deciduous at another part of the dry season. If we see it semi-green, we at least know that it is not evergreen, but we cannot call it semideciduous for we cannot say it might not be fully deciduous at another part of the dry season. However, if we see it already fully deciduous, we know it *is* that.

For permanently leafless (aphyllous) plants, whose stems are the photosynthetic organs, the shedding of these or parts of these should be considered like leaves to determine the degree of deciduousness.

B. Terms for the seasonality of the herbaceous layer as found at any one time. The percents refer to the proportion of the herbaceous cover that is *present* that looks alive. This applies only to stands that are not yet burned during the current burning season, when this is the practice in the region.

1. *All-green*: more than 90% green (or alive, whatever the color).

2. *Semi-green*: 10-90% green.

3. *Non-green*: less than 10% green.

Thus, single visits might yield expressions like "all-green forest (midsummer)", "semi-green arboreal non-green shortgrass savanna (height of dry season)", "semi-green tallherb field (autumn)", "all-green sparse herb field (spring, 1965)", etc.

II. Terms for behavior throughout the year

A. Terms for deciduousness of trees and scrub elements of the principal layer or layers.

1. *Evergreen*: less than 10% leafless at any one time. Although called evergreen the color of the live leaves or other photosynthetic organs does not matter. Desert shrubs that drop their normal size leaves but persist through the dry season with smaller leaves (heterophyllous evergreen) should, of course, be considered evergreen if there is no appreciable period when they lack all

leaves. Aphyllous plants like *Ephedra* and *Equisetum* that have no apparently visible leaves at any time and whose stems are the photosynthetic organs should be considered evergreen if neither the whole shoot nor the branches or branch tips are seasonally shed.

2. *Semideciduous*: (apply whichever is easiest to determine): (a) 10-90% of the individuals leafless at any one time during the year, (b) all or almost all the individuals with less than half their leaves at any one time during the year.

3. *Deciduous*: more than 90% leafless at any one time during the year. Plants with definitely visible and numerous leaves, even though these be small or awl-shaped, which shed their leaves for part of the year, should be considered deciduous or semideciduous as the case may be, even though the stems that remain be photosynthetic. Plants that shed leaflets but retain the leaf rachis are deciduous. Aphyllous plants that shed branches or branch tips seasonally are deciduous.

For stands whose trees and scrub elements vary from year to year in maximum deciduousness due to fluctuating climate, the expression "evergreen (semideciduous in some years) . . .", "semideciduous (deciduous in driest years) . . .", etc., may be used.

B. Terms for seasonality of the herbaceous layer.

1. *Evergreen*: herbaceous layer alive and not appreciably diminished in cover value throughout the year.

2. *Seasonal*: 10% or more of the herbaceous layer yellows or dies or disappears at some time during the year. The dead tissues may dry up or freeze, then turn brown and either persist or disappear even for a short time by rotting or crumbling away, or 10% or more of the herbaceous layer may be periodically covered by soil material, snow, etc., or be carried away by water currents in seasonal rises of the stream, etc. Some cover, alive or dead on the stem, must be visible for three months or more during the year.

3. *Ephemeral*: herbaceous layer, alive or dead on the stem, visible for less than three months of the year, for whatever reason.

Thus, we have expressions like "evergreen tallgrass field", "ephemeral shorterb field", "evergreen broadleaf tree evergreen tallherb savanna", "evergreen broadleaf tree seasonal tallgrass savanna", "semideciduous broadleaf tree seasonal shortgrass savanna", "deciduous broadleaf scrub seasonal shortgrass savanna", etc.

For a more detailed classification of seasonality and its terminology, see the optional criteria in the Appendix.

A stand of vegetation not disturbed by human interference is a resultant of the species available in the region and of the environment as a whole, climatic, substratal and biotic. When woody or otherwise persistent plants are present, then, as far as the seed source, substratal and biotic factors permit, the persistent part of the vegetation represents an integration of the average climate during the previous years. The number of years over which the climate has entered as a causal factor in the existence of a present stand of vegetation depends on the life span of the persistent plants in it. A certain climate, for

instance, may permit the establishment of certain long-lived trees, then change so that these trees can no longer establish themselves but yet permit the continuance of the individuals already grown. The perennial aerial framework of the vegetation, then, represents the resultant of a moving average of the climate that smooths out seasonal changes and year to year irregularities and changes only as a result of long-term climatic changes. On the other hand, the degree of deciduousness of many (if not all) of the woody plants is due to a large extent to the immediate weather of any one growing season, as is also the presence, growth in height, and degree of cover of the herbaceous layer in savannas, sparse woodlands and herbaceous fields*.

In regions of irregular climate where the maximum cover of the herbaceous layer varies from year to year, and these variations are known, one can put the less common state in parentheses at the end of the expression. Thus, "tallgrass field (sparse grass field in driest years)", "arboreal savanna (sparse herbaceous cover in some years)", etc.

LIST OF VEGETATION FORMS

The Roman-numbered categories in the following list include all the structural forms distinguished in the present system, that is, those based on height and spacing. The Arabic-numbered ultimate categories, the "vegetation forms", incorporate the remaining criteria of growth form and vegetative periodicity. This list of vegetation forms is not meant to be exhaustive although it probably includes the majority of forms likely to be met with. Stands containing other growth forms than those mentioned, or mixtures not mentioned, can easily be fitted into the terminology presented here.

The examples under each vegetation form were taken from FOSBERG's original paper (1961), from AZEVEDO (1967), BARNARD (1964), BURTT (1942), COSTIN (1959), COTTLE (1931, 1932), CUATRECASAS (1958), CURTIS (1959), DANSEREAU (1957), EYRE (1963), GOOD (1953), GRIGGS (1934), HEDBERG (1964), LINDMAN (1906), LOVELESS & ASPREY (1957), MARK (1965), MARTIN (1959), MIRANDA & HERNÁNDEZ X. (1963), SCHIMPER (1903), SMILEY (1965), STEYER-MARK (1966), VESEY-FITZGERALD (1957), WACE (1961), WARDLE (1965), WEBB (1959), WETTSTEIN (1935), ZOHARY (1962), from the Brazilian geographical and botanical literature, and from my own observations in the United States, Europe, Cuba, Mexico and Brazil. In some cases, the examples under a single vegetation form are grouped by leaf size, height of the scrub layer, or site. This is to show that the same vegetation form, as defined here, can occur in variations based on criteria not used in defining the form, and can occur in various types of environment. The examples are not meant to be exhaustive, of course, but to show that the classification can be used for stands in all parts of the world.

By using the optional criteria in the Appendix more information may be incorporated, although in most cases this will increase the length of the

* A series of consecutive low seed-production years for annuals, or of unfavorable growth years for herbaceous perennials, can limit the abundance of these plants in a future favorable year.

expression so that it becomes more a description than a name. Some of the names listed are already quite long. Probably the most useful of the optional criteria that could be incorporated is scrub height when this is more or less uniform. The optional criteria have not been used in forming the names in the following list.

I. FOREST WITH EMERGENTS

(When not specified otherwise the emergents have the same deciduousness and growth form as the canopy trees.)

1. Evergreen broadleaf forest with emergents.

Ex.: dipterocarp forest (Ceylon); some Amazonian "terra firme" forests; many areas of secondary forest with canopy over 7 m tall and with remnant tall original trees of the primary or older secondary forest (humid Tropics).

2. Evergreen broadleaf forest with emergent conifers.

Ex.: rainforest with emergent *araucaria* (eastern Australia).

3. Deciduous broadleaf forest with emergents.

Ex.: "deciduous vine thicket" of WEBB (1959) (Cape York Peninsula, northeastern Australia).

4. Deciduous broadleaf forest with emergent conifers.

Ex.: original *Pinus strobus*-hardwood forests of southern New England, U.S.A.).

II. FOREST

(In mixed types all the growth forms mentioned make up a conspicuous part of the canopy.)

5. Evergreen broadleaf forest.

Ex.: mesophyll types: many primary and mature secondary rainforests in the humid Tropics; virgin "terra firme" forests (Amazon); virgin "igapó" (permanently flooded) forests (Amazon); virgin "várzea" (periodically flooded) forests (Amazon); virgin and tall secondary forests of the Serra do Mar (eastern Brazil); "mesophyll vine forest" (WEBB, 1959) (northeastern Australia); rare phases of "cerrado" (Brazil); *Barringtonia racemosa* swamp forest (Guam); taller phases of the "caatinga" forests of the Rio Negro region (Amazon) (some types gnarled, some straight); mangrove forests over 7 m tall; dry evergreen forest (Ceylon); *Diospyros-Osmanthus* forest (Hawaiian Islands); *Arbutus-Umbellaria* forest (California); *Laurus* forest (Canary Islands); evergreen *Quercus* forests (Mexico);

microphyll types: *Leucaena glauca* forest (Palau Island); *Prosopis* forest (Hawaiian Islands); taller aspects of *Leptospermum* (manuka) forest (New Zealand); *Pemphis acidulus* forest (Pacific);

gnarled types: *Metrosideros-Eugenia-Cheirodendron* forest (Hawaiian Islands); taller phases of most cloud forest types; montane forest (Ceylon).

6. Evergreen broadleaf and conifer forest.

Ex.: mixed mesophyll broadleaf & *Araucaria angustifolia* forest (highlands of southern Brazil).

7. Evergreen broadleaf, conifer and palm forest.

Ex.: mixed mesophyll broadleaf, *Araucaria angustifolia* and *Cocos (Arecastrum) romanzoffiana* forest (highlands of southern Brazil).

8. Conifer forest.

Ex.: forests of *Pinus*, *Picea*, *Abies*, etc., and mixtures of these, of *Pseudotsuga*, *Sequoia*, *Araucaria*, etc., on drained soil, swamps, bogs; *Tsuga canadensis* groves (northeastern U.S.A.).

9. Casuarina forest.

Ex.: pure or almost pure casuarina stands (Australia).

10. Palm forest.

Ex.: babaçu groves and forests (*Orbignya barbosiana*) (Maranhão, Brazil); carnaúba groves (*Copernicia prunifera*) (Piauí, Brazil); carandá forest (*Copernicia australis*) (southwestern Mato Grosso, Brazil); closed phases of buriti groves (*Mauritia vinifera*) (central and northern Brazil); closed phases of "morichales" gallery groves of *Mauritia flexuosa* (Venezuelan llanos); coconut groves (*Cocos nucifera*) (Pacific); *Washingtonia* groves (California); closed phases of royal palm groves (*Oreodoxa regia*) (Cuba).

11. Evergreen broadleaf and palm forest.

Ex.: virgin babaçu forest (eastern Pará, northern Goiás & northwestern Maranhão, Brazil).

12. Cecropia forest.

Ex.: pure cecropia groves springing up after primary humid forest clearing in some areas (humid tropical America).

13. Pandanus forest.

Ex.: pandanus swamp forest (Pacific).

14. Cactus forest.

Ex.: *Neobuxbaumia tetetzo* dense stand (Oaxaca, Mexico).

15. Semideciduous broadleaf forest.

Ex.: closed phases of "cerradão" (São Paulo, Goiás, Mato Grosso); dry forest belt on southern and eastern border of the Amazon Hylaea (Mato Grosso, Brazil); dryish forest patches and galleries (central Brazil); "dry evergreen thicket" (Jamaica); moist teak forests (Burma); "dry evergreen forest" (West Africa); "semi-evergreen seasonal forest" (Trinidad); "cedrela" facies of forest form of "caatinga" vegetation (near Januária, Minas Gerais, Brazil); *Brosimum alicastrum* and other semideciduous broadleaf forest types (Chiapas, Mexico).

16. Semideciduous conifer forest.

Ex.: "northern wet forest" dominated by *Larix laricina* and *Picea mariana* (Wisconsin, U.S.A.).

17. Deciduous broadleaf forest.

Ex.: winter-deciduous mesophyll types: *Fagus-Acer-Betula* forest (eastern North America); *Quercus-Carya* forest (eastern U.S.A.); other mixed hardwood forests with conifers absent (eastern U.S.A.); *Fagus* forest (Europe); *Quercus* forest (Europe); *Nyssa* swamp forest (southeastern U.S.A.); *Acer rubrum* swamp forest (eastern U.S.A.); gallery forest in prairie (western Mississippi Valley, U.S.A.);

dry-season deciduous mesophyll types: deciduous dipterocarp forests in southeast Asia, such as "indaing" forest in Burma; most monsoon forests in southeast Asia, such as dry teak forest in Burma; some non-palm gallery forests (southeastern Maranhão, Brazil); patches of dry upland forest, generally on limestone (central Brazil); forest forms of the "caatinga" vegetation

(northeastern Brazil); many forests in Mexico and Central America; "deciduous seasonal forest" (Tobago, West Indies);

dry-season deciduous microphyll types: *Albizzia lebbek* forest (Saipan);

dry-season deciduous mesophyll-microphyll types: "djati" forest (eastern Java); arboreal phases of true "caatinga" (northeastern Brazil).

18. Deciduous broadleaf and conifer forest.

Ex.: hardwood-conifer forests (eastern North America).

19. Deciduous conifer forest.

Ex.: *Larix dahurica* forest (eastern Siberia); *Larix laricina* swamp forest (northern North America); *Taxodium* swamp forest (southeastern U.S.A.).

20. Deciduous broadleaf and palm forest.

Ex.: patches of virgin or long undisturbed babaçu forest (southeastern Maranhão and adjacent Piauí, Brazil).

III. LOW FOREST WITH EMERGENTS

(When not specified otherwise the emergents have the same deciduousness and growth form as the canopy trees.)

21. Evergreen broadleaf low forest with emergents.

Ex.: many areas of secondary forest with canopy less than 7 m tall and with scattered tall remnant original trees (humid Tropics).

22. Deciduous broadleaf low forest with emergents.

Ex.: similar to n.º 21, but in humid temperate zone or dry Tropics.

IV. LOW FOREST

23. Evergreen broadleaf low forest.

Ex.: lower phases of "caatinga" forests of the Rio Negro region (Amazon) (some types gnarled, some straight); young tree stages of secondary forest after complete clearing (humid Tropics).

24. Tree-senecio low forest.

Ex.: closed phases of tree-senecio forest (Mt. Ruwenzori, Uganda).

25. Semideciduous broadleaf low forest.

Ex.: dense, secondary arboreal "cerrado" when less than 7 m tall (São Paulo, Brazil); *Ilex opaca-Sassafras albidum* forest (Sunken Forest, Fire Island; New York, U.S.A.).

26. Deciduous broadleaf low forest.

Ex.: young tree stages of secondary forest after complete clearing and where conifers are lacking (humid temperate zone); young tree stages of secondary forest after complete clearing in the dry Tropics.

V. OPEN FOREST WITH CLOSED SCRUB

(When not specified otherwise the scrub layer is made up of shrubs with the same deciduousness as the trees.)

27. Evergreen broadleaf open forest with closed scrub.

Ex.: partially cut or burned primary or tall secondary forest with regeneration of undergrowth (humid Tropics).

28. Evergreen broadleaf open forest with deciduous broadleaf closed scrub.

Ex.: natural open forest of *Parkia platycephala* with underlayer of medium-tall closed scrub of *Combretum* and *Mimosa* spp., a form of "cerradão" transitional to thorn scrub "caatinga" (west central Piauí, Brazil).

29. Semideciduous broadleaf open forest with closed scrub.

Ex.: some phases of "cerradão" (Brazil).

30. Open conifer forest with evergreen broadleaf closed scrub.

Ex.: *Araucaria angustifolia* groves with cleared and partially regenerated broadleaf layer (highlands of southern Brazil).

31. Open conifer forest with deciduous broadleaf closed scrub.

Ex.: denser phases of pinyon and pinyon-juniper (*Pinus-Juniperus*) "woodlands" with closed low shrubby layers (Rocky Mountains and east slope of the Sierra Nevada, western U.S.A.).

32. Open palm forest with evergreen broadleaf closed scrub.

Ex.: tall *Ceroxylon* palms overtopping closed subandine scrub (Rio Palo, Cauca, Colombia).

33. Semideciduous broadleaf and palm open forest with deciduous broadleaf and bamboo closed scrub.

Ex.: burnt-over gallery forests, originally with closed canopy, now opened, and with regenerated undergrowth (northern Goiás, Brazil).

34. Deciduous broadleaf open forest with closed scrub.

Ex.: partially cut-over (originally closed) deciduous gallery forest with remnant tall trees forming an open canopy, and subsequently developed closed scrub layer (southeastern Maranhão, Brazil); phases of natural undisturbed "tabuleiro" woodland when possessing a closed low shrub layer (southeastern Maranhão, Brazil); partially cut-over hardwood forest with subsequent regeneration of a closed shrubby layer (humid temperate zone).

35. Deciduous broadleaf open forest with closed bromeliad scrub.

Ex.: some phases of natural undisturbed "varjão", a tall-tree gallery woodland of angico (*Anadenanthera colubrina* var. *cebil*) with a closed dwarf scrub layer of *Bromelia* sp. (southeastern Maranhão, Brazil).

VI. OPEN LOW FOREST WITH CLOSED SCRUB

(When not specified otherwise the scrub layer is made up of shrubs with the same deciduousness as the trees.)

36. Evergreen broadleaf open low forest with closed scrub.

Ex.: partially cut-over or burnt-over low secondary forests with regenerated scrub (humid Tropics).

37. Open low conifer forest with deciduous broadleaf closed scrub.

Ex.: *Juniperus virginiana* open low forest (with small total amount of *Ilex opaca*, *Prunus serotina* and *Amelanchier canadensis* in the canopy) and with a closed low scrub of *Rhus radicans*, *Rosa virginiana*, *Vaccinium vacillans* and *Myrica pensylvanica* filling the interstices (Island Beach, New Jersey, U.S.A.). Although the tree layer here is not only of conifers, and the shrub layer is not completely deciduous, the given name is appropriate because the layers are almost completely as described.

38. Tree-senecio open low forest with closed evergreen broadleaf scrub.

Ex.: *Helichrysum stuhlmannii* low scrub with *Senecio adnivalis* (Mt. Ruwenzori, Uganda).

39. Semideciduous broadleaf open low forest with closed scrub.

Ex.: some phases of "cerrado" (Brazil).

40. Deciduous broadleaf open low forest with closed cactus scrub.

Ex.: xerophytic formation of *Prosopis juliflora* trees over *Opuntia* (near Cúcuta, Norte de Santander, Colombia).

VII. UNEVEN CLOSED TREES AND SCRUB

(When not specified otherwise the scrub is made up of shrubs with the same deciduousness as the trees.)

41. Semideciduous broadleaf uneven closed trees and scrub.

Ex.: certain phases of partially cut-over "cerradão" with remnant medium-tall trees and with shrub and young tree regeneration (São Paulo, Brazil); natural stands of "cerrado" (northeastern Mato Grosso, Brazil).

42. Deciduous broadleaf uneven trees and scrub.

Ex.: phases of cut-over secondary forest with remnant trees and with shrub and young tree regeneration (humid temperate zone).

VIII. UNEVEN CLOSED LOW TREES AND SCRUB

(When not specified otherwise the scrub is made up of shrubs with the same deciduousness as the trees.)

43. Uneven closed low tree and scrub community of cycads.

Ex.: closed stands of *Encephalartos transvenosus* (Transvaal, South Africa).

44. Semideciduous broadleaf uneven closed low trees and scrub.

Ex.: certain phases of closed "cerrado" (secondary in São Paulo, apparently natural in north central Goiás, and certainly natural in n. e. Mato Grosso).

IX. CLOSED SCRUB WITH EMERGENTS

(When not specified otherwise the emergents have the same deciduousness and growth form as the scrub elements.)

45. Evergreen broadleaf closed scrub with emergent trees.

Ex.: *Scaevola* scrub with scattered trees (Pacific coral islands); scrub oak with scattered live oaks (*Quercus*) (California); *Artemisia californica* with *Quercus* (California); "páramo" of closed scrub with emergent *Weinmannia engleriana* (headwaters of the Rio Palo, Cauca, Colombia); cut-over forests with remnant trees and beginning of regeneration (humid Tropics).

46. Evergreen broadleaf closed scrub with emergent trees and tree-ferns.

Ex.: "páramo" of closed medium-tall scrub with scattered *Weinmannia penicillata* trees and tall tree-ferns (Los Parallones, Cordillera Occidental, Colombia).

47. Evergreen broadleaf closed scrub with emergent tree-conifers.

Ex.: scrub layer over 1/2 m tall: "chaparral" with scattered *Pinus* (California); "maquis" with scattered *Pinus* (Mediterranean); *Purshia tridentata* with *Pinus* (western U.S.A.);

scrub layer less than 1/2 m tall: *Calluna* heath with *Pinus* (north-west Europe). (If it is felt that it is forcing the meaning of "evergreen broadleaf" to apply it to *Calluna*, the stand may be called "evergreen ericoid closed dwarf scrub with emergent conifers".)

48. Evergreen broadleaf closed scrub with emergent deciduous broadleaf trees and tree-conifers.

Ex.: *Kalmia latifolia* scrub with scattered *Quercus* and *Pinus* (Virginia mountains, U.S.A.).

49. Evergreen broadleaf closed scrub with emergent deciduous broadleaf trees.

Ex.: *Empetrum* phase of heath birch (*Betula*) forest (Lapland).

50. Semideciduous broadleaf closed scrub with emergent trees.

Ex.: certain aspects of "cerrado" (Brazil), the scrub layer in this form being more or less uniform in height; "carrascal" formation (near Januária, Minas Gerais, Brazil).

51. Semideciduous broadleaf closed scrub with emergent scrub-conifers.

Ex.: *Chamaedaphne calyculata* bog with invading low *Picea mariana* (northern North America). Authorities differ as to whether *Chamaedaphne calyculata* is semideciduous (SEGADAS-VIANNA, 1955, p. 649) or evergreen (CURTIS, 1959, p. 379).

52. Deciduous broadleaf closed scrub with emergent trees.

Ex.: scrub layer over 1/2 m tall: cut-over temperate hardwood forests with scattered remnant trees and regenerated layer of shrubs and young trees; some areas of dense, secondary, medium-tall "cerrado" scrub with scattered remnant trees (southeastern Maranhão);

scrub layer less than 1/2 m tall: *Vaccinium* phase of heath birch (*Betula*) forest (Lapland).

53. Deciduous broadleaf closed scrub with emergent tree-conifers.

Ex.: *Quercus ilicifolia* scrub with scattered *Pinus rigida* (Appalachian Mountains, eastern U.S.A.); *Baccharis halimifolia* scrub with emergent *Juniperus virginiana* (Island Beach, New Jersey, U.S.A.).

54. Deciduous broadleaf closed scrub with emergent cacti.

Ex.: *Cephalocereus colombianus* over closed low scrub (xerophytic enclave at Dágua, Colombia).

55. Deciduous broadleaf closed scrub with emergent trees and tree-cacti.

Ex.: large areas of medium-tall thorn scrub "caatinga" (northeastern Brazil).

56. Deciduous broadleaf and palm closed scrub with emergent tree-cacti.

Ex.: "caatinga" of Moxotó Plateau, Pernambuco, Brazil. An essentially continuous medium-tall scrub (to 2 m) of deciduous broadleaf shrubs and ouricuri palms (*Cocos coronata*) overtopped by numerous scattered tree-cacti (*Cereus*) 4-5 m tall.

X. CLOSED SCRUB

57. Evergreen broadleaf closed scrub.

Ex.: over 1/2 m tall: *Scaevola* scrub (dry coral islands), coastal sagebrush when dominated by *Salvia* (California); closed phases of sagebrush (*Artemisia tridentata*) (Great Basin, U.S.A.); low stages of return to forest in humid Tropics after complete clearing; *Hibiscus tiliaceus* swamp (tropical coasts); stabilized dune scrub in humid Tropics; low phases of mangrove swamp; *Rhododendron* swamps (eastern North America); secondary scrub (Colombian Andes); "maquis" (Mediterranean); *Ceanothus* chaparral (California); *Quercus dumosa* chaparral (California); *Rhododendron maximum* scrub (eastern U.S.A.); *Rhododendron catawbiense* "balds" (southern Appalachian Mountains, U.S.A.); sclerophyll scrubby "Cape vegetation" (South Africa); *Quercus*

calliprinos maquis (upper Galilee, Palestine); carob-lentisk (*Ceratonia siliqua-Pistacia lentiscus*) maquis groves on consolidated sand dunes (Sharon Plain, Palestine); *Acacia farnesia* scrub (Tropics); *Leucaena glauca* scrub (Pacific); *Ilex vomitoria* scrub (southeastern U.S.A.);

dwarf scrub forms (less than 1/2 m tall): *Rhododendron* mat (eastern Himalayas); *Chamaedaphne* bog (evergreen type, eastern North America); *Arctostaphylos uva-ursi* mat (North Temperate region); coastal *Osteomeles* scrub (Miyako Island in the Ryukyus); *Empetrum* heath (Arctic, Subarctic, Subantarctic); *Loiseleuria* heath (Arctic); *Calluna* heath (western Europe). The last example can also be called "evergreen ericoid closed dwarf scrub".

58. Evergreen broadleaf and conifer closed scrub.

Ex.: Mats of *Hudsonia*, *Juniperus* and *Arctostaphylos* on sand dunes (Wisconsin, U.S.A.).

59. Closed conifer scrub.

Ex.: *Pinus pumila* scrub (Japan); *Pinus mugo* scrub (Tyrol); *Juniperus horizontalis* mats on rock ledges, sand dunes, etc. (Wisconsin, U.S.A.).

60. Closed conifer krummholz.

Ex.: *Pinus flexilis* krummholz (Rocky Mountains, U.S.A.)

61. Closed tree-fern scrub.

Ex.: *Blechnum palmiforme* heath (Gough Island, South Atlantic).

62. Closed vellozia scrub.

Ex.: dense pure *Vellozia* "campos" (high altitudes of central Brazil).

63. Closed palm scrub.

Ex.: many areas of natural forest regeneration after clear cutting where palms existed in the undergrowth and continue to resist subsequent fires better than the mesophylls (humid Tropics); regenerating stages of clear-cut palm forests (Tropics); small areas of acaulescent palm stands, such as *Attalea geraensis*, in "cerrado" in southern Brazil, where mesophylls are few.

64. Closed bamboo scrub.

Ex.: *Chusquea* brake (Andes; top of Mt. Itatiaia, Brazil); *Pleioblastus* brake (Ryukyu Islands).

65. Lobelia-senecio closed scrub.

Ex.: tall dense scrub of mixed giant-senecio and giant *Lobelia wollastonii* (Mt. Muhavura, Uganda).

66. Semideciduous broadleaf closed scrub.

Ex.: dense phases of low forms of "cerrado", may be natural or due to disturbance (Brazil); medium-tall "caatinga" on sandstone plateaus (southern Piauí, Brazil); low-shrub "caatinga" (near Januária, Minas Gerais, Brazil); "evergreen bushland" (Jamaica); *Chamaedaphne calyculata* bog (semideciduous type, eastern North America).

67. Semideciduous broadleaf and tree-cactus closed scrub.

Ex.: "cactus scrub" (*Acacia tortuosa-Lemaireocereus hystrix*) (Jamaica).

68. Deciduous broadleaf closed scrub.

Ex.: over 1/2 m tall: winter-deciduous types: *Salix* scrub (Arctic & Subarctic); *Spiraea* scrub (eastern U.S.A.); *Crataegus* thicket (eastern U.S.A.); alder (*Alnus*) swamps (eastern U.S.A., Europe);

dry-season deciduous types: mangrove swamps (Guajira Peninsula, Colombia); *Excoecaria* swamps (southeast Asia); *Leucaena glauca* scrub (East

Java); "tabuleiro vegetation" of southern Bahia and northern Minas Gerais, Brazil, a non-spiny variant of "caatinga"; large areas of thorn scrub "caatinga" where cacti are not prominent (northeastern Brazil); lower phases of "tabuleiro" variety of "cerrado" (southeastern Maranhão, Brazil); *Acacia* thicket (East Africa); Itigi thicket (Nyassaland);

dwarf scrub forms (less than 1/2 m tall): closed phases of low bush *Vaccinium* scrub (North Temperate & Subarctic regions); closed phases of *Vaccinium myrtillus* heath (Subarctic).

69. Deciduous broadleaf and conifer closed scrub.

Ex.: medium-tall scrub of *Pinus rigida*, *Quercus ilicifolia* and *Q. marilandica* ("The Plains", New Jersey Pine Barrens, U.S.A.).

70. Deciduous broadleaf and tree-cactus closed scrub.

Ex.: many areas of "caatinga" (northeastern Brazil); xerophytic enclaves in mountains near Dágua, Colombia.

71. Deciduous broadleaf and cactoid-Euphorbia closed scrub.

Ex.: thorn scrub (northern Transvaal, South Africa).

72. Deciduous conifer closed scrub.

Ex.: low phases of *Larix laricina* swamp (northeastern North America).

XI. WOODLAND

(Open forest with undergrowth scrub layer not closed.)

73. Evergreen broadleaf woodland.

Ex.: denser phases of niaouli (*Melaleuca*) vegetation (New Caledonia); denser phases of Orinoco "savanna"; open *Quercus* forest (northern Thailand); live oak (*Quercus*) woodland (California), subalpine *Eucalyptus niphophylla* woodland (southeastern Australian mountains); natural evergreen stands of "chapada" variety of "cerradão" (southern Maranhão, Brazil); dry woodland (Nyassaland); open phases of *Prosopis* forest (Hawaii).

74. Conifer woodland.

Ex.: open *Pinus* forest (Philippines, Mexico, Cuba, southeastern U.S.A., Ryukyus, etc.); open aspects of Pine Barrens (southern New Jersey, U.S.A.); denser aspects of pinyon, or juniper, or pinyon-juniper (*Pinus edulis-Juniperus monosperma*) woodlands with open or sparse shrubby layer or with grassy herbaceous layer only (Rocky Mountains and its foothills, east slope of the Sierra Nevada, southwestern Texas, all in western U.S.A.); *Pinus ponderosa* "forest" with grassy layer (western U.S.A.); denser phases of cedar "glades" (*Juniperus virginiana*) on limestone (scattered in eastern U.S.A.); open non-krummholz timberline forest of *Picea engelmannii* and *Abies lasiocarpa* (Rocky Mountains, Colorado, U.S.A.).

75. Conifer and palm woodland.

Ex.: mixed *Pinus tropicalis* and *Colpothrinax Wrightii* groves (Isle of Pines, Cuba).

76. Palm woodland.

Ex.: *Mauritia* groves (Colombian "llanos"); *Sabal* forest (Mexico); open phases of babaçu and carnaúba groves (*Orbignya barbosiana* and other arboreal *Orbignya* spp., and *Copernicia prunifera*) (northeastern Brazil); *Borassus* forest (northwestern India, western Ceylon); *Phoenix dactylifera* groves in oases (Arabia, North Africa); dense stand of *Cocos romanzoffiana* in grassy

upland pasture (Itapeva, São Paulo, Brazil). The last example is a derived vegetation. Scattered canopy palms of a *Cocos romanzoffiana*-*Araucaria angustifolia*-evergreen broadleaf forest were left as remnants when the forest was cleared to make pasture. The palm's fleshy fruits were eaten and spread by cattle so that the palm stand became denser.

77. Casuarina woodland.

Ex.: open phases of casuarina forests (western Pacific).

78. Tree-lobelia and tree-senecio woodland.

Ex.: alpine part of Mt. Ruwenzori, Uganda. This could also be called "rosette-tree woodland".

79. Semideciduous broadleaf woodland.

Ex.: natural semideciduous stands of "chapada" variety of "cerradão" (southern Maranhão, Brazil); open phases of "cerradão", the openness probably due to previous repeated fires (São Paulo, Brazil).

80. Deciduous broadleaf woodland.

Ex.: deciduous dipterocarp open forest (Thailand); "forêt-claire" (Indo-China); naturally open gallery forest of the types locally called "caatinga" and "varjao" when these are without closed scrub layer (southeastern Maranhão, Brazil); grassy open forest (Katanga Province, Congo); "miombo" (*Brachystegia* or *Isoberlinia-Brachystegia*) woodland (south central Africa); *Acacia* woodlands (denser phases of *Acacia* savannas, East Africa); *Combretum* woodlands (East Africa); taller phases of open *Quercus* forest (sandhills of southeastern U.S.A.); "oak openings" (*Quercus macrocarpa*) of prairie-forest border (Midwest region of U.S.A.); limestone "glades" where hardwood trees predominate (Missouri, U.S.A.).

81. Deciduous conifer woodland.

Ex.: open *Larix laricina* forest or "muskeg" when scrub layer is not closed (central Canada).

XII. LOW WOODLAND

82. Evergreen broadleaf low woodland.

Ex.: *Prosopis* forests (Hawaii, Caribbean); low phases of *Diospyros-Osmanthus* forest (Lanai, Hawaiian Islands); denser phases of arboriform *Byrsonima crassifolia* savanna (Chiapas, Mexico); *Quercus grisea* woodland with shortgrass cover on north-facing slopes (southwestern Texas).

83. Cycad low woodland.

Ex.: open stands of *Encephalartos transvenosus* (Transvaal, South Africa).

84. Tree-senecio low woodland.

Ex.: *Senecio keniodendron* woodland (Mt. Kenya); *Senecio adnivalis* woodland (Mt. Ruwenzori, Uganda); *Senecio barbatipes* woodland (Elgon, Uganda). This could also be called "rosette-tree low woodland".

85. Cactus low woodland.

Ex.: pure *Lemaireocereus thuberti* stand (Sonora, Mexico).

86. Semideciduous broadleaf low woodland.

Ex.: phases of arboreal "cerrado" on pure sand (southern Maranhão, Brazil).

87. Deciduous broadleaf low woodland.

Ex.: lower phases of open *Quercus* forest (sandhills of southeastern

U.S.A.); some stands of periodically much-burnt "chapada" variety of "ceradão" (southeastern Maranhão, Brazil); lower phases of "tabuleiro" woodland (southeastern Maranhão, Brazil).

XIII. TREE AND SCRUB WOODLAND

88. Evergreen broadleaf tree and scrub woodland.

Ex.: areas of forest in humid Tropics opened by cutting and fire with some regeneration of shrubs but these not yet forming a closed layer.

89. Woodland of tree-lobelias and evergreen broadleaf scrub.

Ex.: open low shrubbery of *Helichrysum* spp. with scattered *Senecio elgonensis* (Elgon, Uganda).

90. Woodland of palms and evergreen broadleaf scrub.

Ex.: open low scrub of *Quercus oleoides* with scattered *Sabal mexicana* (Alvarado, Vera Cruz, Mexico).

91. Semideciduous broadleaf tree and scrub woodland.

Ex.: a common phase of "cerrado" (Brazil).

92. Deciduous broadleaf tree and scrub woodland.

Ex.: areas of forest in humid temperate regions or dry Tropics opened by cutting and fire, with some regeneration of shrubs, but these not forming a closed cover. Many pastures are of this type, the grazing and continued burnings preventing a closing of the woody cover; natural dry woodland of *Cercidium microphyllum*, *Larrea tridentata*, *Olneya tesota*, etc. (Sonora, Mexico).

93. Woodland of tree-yucca and semideciduous broadleaf scrub.

Ex.: medium-tall open scrub of *Larrea tridentata* and *Prosopis juliflora* with emergent scattered *Yucca filifera* (San Luiz Potosí, Mexico); low open scrub of *Larrea tridentata* and *Zaluzania triloba* with emergent scattered *Samuela carnerosana* (San Luiz Potosí, Mexico). If the scrub layer were denser here, these would be examples of closed scrub with emergent tree-yucca.

94. Woodland of tree-cactus and deciduous broadleaf scrub.

Ex.: *Cereus giganteus* desert with denser phases of shrub layer (Sonoran Desert, southwestern North America).

XIV. OPEN SCRUB

95. Evergreen broadleaf open scrub.

Ex.: more than 1/2 m tall: "mallee bush" (shrubby *Eucalyptus*) (Australia); taller open forms of "garrigue" (Mediterranean); denser and lower phases of *Curatella-Byrsonima* "savanna" (northern Tropical America); *Sida falax* scrub (northern Marshall Islands); mulga (*Acacia aneura*) scrub (Australia); serpentine scrub (New Caledonia); tola (*Lepidophyllum*) heath (Peru, Bolivia); open aspects of taller *Calluna-Erica* heath (western Europe) (this may also be called "evergreen ericoid open low scrub"); open phases of sagebrush (*Artemisia tridentata*) (Great Basin, U.S.A.); *Sarcobatus* flats (Great Basin, U.S.A.); *Tamarix* scrub (arid areas in Mediterranean, Central Asia, southwestern U.S.A.); shrubby *Atriplex* flats (Great Basin, U.S.A.); phase of "vasante" vegetation on river valley floor, a low to medium-tall scrub (near Januária, Minas Gerais, Brazil);

dwarf forms (less than 1/2 m tall); dwarf phases of open "garrigue" (Mediterranean); low dense phases of tola (*Lepidophyllum*) heath (Peru,

Bolivia); *Sida-Heliotropium* dwarf scrub (Christmas Island, Pacific); open phase of mountain bog (Hawaii); lower phases of open *Calluna* heath and of open *Erica* heath (northern Europe). This last may also be called "evergreen ericoid open dwarf scrub".

96. Evergreen broadleaf open clumped scrub.

Ex.: inner "restinga" vegetation at Cabo Frio, Rio de Janeiro, Brazil.

97. Evergreen broadleaf and palm open scrub.

Ex.: *Curatella americana*, *Byrsonima crassifolia* and *Acoelorrhaphe Wrightii* dense "savanna" (Isle of Pines, Cuba).

98. Open conifer krummholz.

Ex.: open *Pinus flexilis* krummholz (Rocky Mountains, U.S.A.); open aspects of *Picea* krummholz (White Mountains, New Hampshire, U.S.A.); open *Larix* krummholz (Sakhalin Island).

99. Evergreen broadleaf and conifer open scrub.

Ex.: open scrub to 2 m tall with scattered *Pinus tropicalis* 3 m tall (Isle of Pines, Cuba). The pine is not sufficiently tall here in relation to the rest of the scrub to warrant calling the stand a tree and scrub woodland.

100. Evergreen broadleaf and cactus open scrub.

Ex.: *Myrtillocactus geometrizans* and *Larrea tridentata* scrub (San Luiz Potosí, Mexico).

101. Open palm scrub.

Ex.: *Serenoa* "prairie" (Florida, U.S.A.); *Chamaerops humilis* scrub (Algeria).

102. Open Espeletia scrub.

Ex.: open, low to medium-tall *Espeletia* scrub ("páramo", Sierra Nevada de Cocuy, Colombia); open medium-tall scrub of *Espeletia hartwegiana* with carpet of *Calamagrostis coarctata* grass ("páramo" at Laguna del Ruiz, Cordillera Central, Colombia); open low scrub of *Espeletia conglomerata* with closed cover of *Calamagrostis effusa* grass (Páramo del Almorzadero, Cordillera Oriental, Colombia); open low scrub of *Espeletia estanislana* with closed layer of short marsh grasses (marsh, Páramo del Almorzadero, Cordillera Oriental, Colombia); open low scrub of *Espeletia* ("páramo" in Estado Mérida, Venezuela).

103. Open Puya scrub.

Ex.: *Puya goudotiana* medium-tall scrub with *Cortaderia nitida* grass ("páramo" near Bogotá, Colombia). Forms 102 and 103 may also be called "rosette-plant open scrub".

104. Open cactus scrub.

Ex.: open tall scrub of *Cereus giganteus* (Mexico); open dwarf scrub of *Opuntia polyacantha* in shortgrass plains of *Bouteloua oligostachya*, *Agropyron pseudo-repens*, etc. (Badlands of South Dakota, U.S.A.).

105. Cactus and agave open scrub.

Ex.: with intermixed shortgrasses (Mexico).

106. Cactus, agave and yucca open scrub.

Ex.: Mexico.

107. Open nolina scrub.

Ex.: *Nolina parviflora* stand (State of Mexico, Mexico). This could also be called "open vellozioid scrub" or, more generally, "rosette-tree open scrub".

108. Open agave scrub.

Ex.: *Agave striata*, *A. lecheguilla*, etc. (Mexico).

109. Cactoid-euphorbia open clumped scrub.

Ex.: *Euphorbia canariensis* on lava field on peak of Teneriffe, Canary Islands.

110. Open cushion scrub.

Ex.: *Azorella selago* stands (Kerguelen Island; open cushion-plant scrubs of *Raoulia*, *Hebe*, *Hectorella*, *Dracophyllum*, *Celmisia viscosa*, *Luzula pumila*, etc., and mixtures of these (alpine screes, New Zealand).

111. Semideciduous broadleaf open scrub.

Ex.: a common aspect of "cerrado" (Brazil); low open scrub of *Rhus radicans*, *Parthenocissus quinquefolia*, *Myrica pensylvanica* and *Salix rotundifolia* (Island Beach, New Jersey, U.S.A.).

112. Vellozia and semideciduous broadleaf open scrub.

Ex.: some areas of high-altitude "cerrado" (Goiás & Minas Gerais, Brazil).

113. Deciduous broadleaf open scrub.

Ex.: more than 1/2 m tall: open phases of *Salix* or *Betula* scrub (Subarctic); denser phases of *Ulmus pumila* scrub (Central Asia); shrubby *Fraxinus* and grass invading bare cracked limestone pavement (Yorkshire, England); grassy phases of *Pentzia-Rhigozum* scrub (South Africa), *Acacia tortilis* scrub in runnels or "draws" (Arizona, U.S.A.); "parque de espinillo" (*Acacia farnesiana*) (Entre Ríos, Argentina); open scrub of *Acacia cavenia* (central Chile); eroded phases of "morraria" variety of "cerrado" (southeastern Maranhão, Brazil); open ocotillo (*Fouquieria splendens*) scrub (Durango, Mexico); overgrazed *Hilaria mutica* shortgrass flats invaded by *Flourensia cernua* (southwestern Texas.)

dwarf forms (less than 1/2 m tall): open phases of low bush *Vaccinium* scrub (eastern U.S.A.); open phases of *Vaccinium myrtillus* heath (Subarctic); deciduous scrub oak and shin oak (*Quercus*) (southwestern U.S.A.).

114. Deciduous broadleaf, cactus and bromeliad open clumped scrub.

Ex.: dry clumped "caatinga" with open bare rocky soil between the clumps (along São Francisco River, southwestern Pernambuco, Brazil).

115. Deciduous broadleaf, yucca and cactus open scrub.

Ex.: *Neobuxbaumia mezcalaensis*, *Yucca periculosa*, *Plumeria rubra*, etc. (Puebla, Mexico).

XV. ARBOREAL TALL SAVANNA

(Herbaceous layer 1 m tall or more. For persistent, trunked elements such as conifers, palms, etc., which may be more or less than 3 m tall, preface "tree-..." to them when they are over 3 m tall. However, for bamboo over 3 m tall, use "tall bamboo".)

A. Grass types**116. Evergreen broadleaf tree evergreen tallgrass savanna.**

Ex.: coastal swamp savanna (West Africa).

117. Evergreen broadleaf tree seasonal tallgrass savanna.

Ex.: live oak (*Quercus*) savannas (California); taller phases of *Curatella-Byrsonima* savanna (northern South America).

118. **Tree-palm evergreen tallgrass savanna.**

Ex.: lightly grazed or ungrazed natural edaphic savannas in Cuba, Colombia, and other areas in humid Tropics; many artificial stands due to clearing of rainforest leaving scattered palms uncut (when not grazed too heavily, but periodically burned to prevent shrub regrowth).

119. **Clumped tree-palm seasonal tallgrass savanna.**

Ex.: ungrazed *Acoelorrhaphe Wrightii* savanna (Cuba).

120. **Tree-Pandanus seasonal tallgrass savanna.**

Ex.: Guam.

121. **Tree-casuarina seasonal tallgrass savanna.**

Ex.: *Casuarina equisetifolia* savanna (Guam).

122. **Clumped tall bamboo evergreen tallgrass savanna.**

Ex.: secondary ungrazed grass fields with scattered clumps and small groves of *Guadua* persisting from original forest because of resistance to periodic fires (Alto Calima, Valle de Cauca, Colombia).

123. **Semideciduous broadleaf tree seasonal tallgrass savanna.**

Ex.: phases of "cerrado" with sparse tree layer, absent or negligible scrub layer, and tall herbaceous layer predominantly of grasses (a form of "campo cerrado") (Brazil).

124. **Deciduous broadleaf tree seasonal tallgrass savanna.**

Ex.: *Adansonia* savanna (Sudan); *Acacia* savanna (Africa) in less thorny and more thorny phases.

B. Fern types

125. **Evergreen broadleaf tree evergreen tallfern savanna.**

Ex.: taller phases of acaulescent fern savanna (Palau Island, Pacific).

C. Mixed grass and fern types

126. **Evergreen broadleaf tree evergreen tall fern and grass savanna.**

Ex.: closed erosion scar community with acaulescent ferns, grasses and *Myrtella* (Guam).

XVI. ARBOREAL SHORT SAVANNA

(Savanna with cover of naturally low herbaceous vegetation (less than 1 m tall) or whose naturally tall herbaceous layer is heavily grazed).

A. Grass types

127. **Evergreen broadleaf tree evergreen shortgrass savanna.**

Ex.: some areas of "campo" (eastern Amapá, Brazil); heavily grazed artificial savannas (formerly forests) in humid Tropics with no appreciable dry season or on permanently moist soil.

128. **Evergreen broadleaf tree seasonal shortgrass savanna.**

Ex.: live oak (*Quercus*) savanna (California); many areas of natural savanna (northern South America); grazed artificial savanna formed by recent clearing of primary rainforest for pasture, leaving scattered original trees and a low continuous grassy ground cover (many areas in humid Tropics with a slight dry season; seen in southwestern São Paulo, Brazil); cleared

grazed, former forest land with scattered introduced trees (example seen with low mango trees near São Carlos, S. Paulo, Brazil).

129. Tree-conifer seasonal shortgrass savanna.

Ex.: *Pinus* savanna (Luzón, Cuba, southeastern U.S.A., eastern foothills of Rocky Mountains, U.S.A.); foothill savanna where *Pinus sabiana* predominates (California); *Juniperus virginiana* glades (eastern U.S.A.); *Picea canadensis* invading graminoid tundra at forest edge (Alaska).

130. Tree-palm seasonal shortgrass savanna.

Ex.: natural shortgrass palm savannas or heavily grazed natural tallgrass palm savannas in many areas in the Tropics with a dry season; grazed derived savannas (formerly forests) in tropical areas with slight or pronounced dry season, where the mesophyll trees were cut out and the palms left. An example of the latter are grassy upland pastures with scattered remnant *Cocos romanzoffiana*, derived from *Cocos romanzoffiana-Araucaria angustifolia*-evergreen broadleaf forest (Itapeva, Sao Paulo, Brazil).

131. Clumped tree-palm seasonal shortgrass savanna.

Ex.: grazed *Acoelorrhaphe Wrightii* savanna (Cuba).

132. Tree-cycad seasonal shortgrass savanna.

Ex.: *Macrozamia* savanna (Queensland, Australia).

133. Clumped tall bamboo evergreen shortgrass savanna.

Ex.: grazed portions of secondary grass fields with scattered clumps of *Guadua* persisting from original forest because of resistance to periodic fires (Alto Calima, Valle del Cauca, Colombia).

134. Tree-Puya evergreen shortgrass savanna.

Ex.: northern Andes.

135. Semideciduous broadleaf tree seasonal shortgrass savanna.

Ex.: phases of "cerrado" with sparse tree layer, absent or negligible shrub layer, and low herbaceous layer (natural or because of grazing) predominantly of grasses (a form of "campo cerrado") (Brazil).

136. Deciduous broadleaf tree seasonal shortgrass savanna.

Ex.: *Quercus lobata* or *Q. douglassii* savanna (California); *Crataegus* pasture where trees are scattered (eastern North America); sparse gallery of scattered trees along water courses in shortgrass plains (Colorado, U.S.A.); more open phases of "oak openings" (prairie-forest border, Midwest region, U.S.A.); *Combretum-Erythrina-Dombeya-Bauhinia* savanna (Thika, Kenya); areas of cut-over "tabuleiro" woodland with scattered remnant trees (southeastern Maranhão, Brazil); deciduous savanna (northern Colombia); *Acacia* and desert grass savanna (Africa).

B. Fern types

137. Evergreen broadleaf tree evergreen shortfern savanna.

Ex.: lower phases of acaulescent fern savanna (Palau Island, Pacific).

C. Moss types

138. Deciduous tree-conifer and moss savanna.

Ex.: sphagnum "muskeg" with scattered *Larix laricina* (Canada).

D. Lichen types

139. Deciduous tree-conifer and lichen savanna.

Ex.: lichen "muskeg" with scattered *Larix laricina* (Canada).

XVII. TREE AND SCRUB TALL SAVANNA

(Trees and scrub elements more or less equally conspicuous. Many natural savannas are of this type, as well as forests and woodlands that have been opened by cutting, fire and grazing, with or without some degree of subsequent regeneration. Herbaceous layer essentially 1 m tall or more.)

140. Semideciduous broadleaf tree and scrub seasonal tallgrass savanna.

Ex.: cut-over "cerradão" woodland with scattered trees and shrubs and invading molassas grass (*Melinis minutiflora*) (São Paulo, Brazil); certain phases of "cerrado" where the tall grasses are not heavily grazed (Brazil). The spacing of the trees and shrubs in this last example may be natural or due to annual burnings.

XVIII. TREE AND SCRUB SHORT SAVANNA

(Trees and scrub elements more or less equally conspicuous. Many natural savannas are of this type, as well as forests and woodlands that have been opened by cutting, fire and grazing, with or without some degree of regeneration. Herbaceous layer naturally less than 1 m tall or low height due to grazing.)

141. Evergreen broadleaf tree and scrub evergreen shortgrass savanna.

Ex.: spinifex grassland (*Triodia basedowii*) with scattered *Eucalyptus* and *Acacia* trees, and shrubs of other genera (on coarse sand plains, Willuna area, northwestern Western Australia).

142. Semideciduous broadleaf tree and scrub seasonal shortgrass savanna.

Ex.: partially cut-over "cerradão" woodland or other "cerrado" vegetation with scattered trees and scrub and natural short grasses (or tall grasses kept low by grazing) (Brazil); periodically-burnt *Curatella-Byrsonima* savanna (Rupununi Savanna, British Guiana).

143. Deciduous broadleaf tree and scrub seasonal shortgrass savanna.

Ex.: some savannas with *Acacia* trees, shrubs, and desert grass (Africa); some areas of cut-over "tabuleiro" woodland with remnant trees and shrubs (southeastern Maranhão, Brazil).

XIX. SCRUB TALL SAVANNA

(For conifers, bamboo, and trunked pachycaul forms which may be over or under 3 m tall, it will be necessary to prefix "scrub- ..." to them to show that they are under 3 m tall.)

A. Grass types

144. Evergreen broadleaf scrub evergreen tallgrass savanna.

Ex.: many areas of grassland with scattered low shrubs and subshrubs in humid Tropics and Subtropics, such as some forms of "campo" in southern Brazil.

145. Evergreen broadleaf scrub seasonal tallgrass savanna.

Ex.: scrub phases of *Curatella-Byrsonima* tallgrass savanna (northern South America); some forms of "campo" (southern Brazil).

146. Semideciduous broadleaf scrub seasonal tallgrass savanna.

Ex.: low open phases of "cerrado" (often called "campo cerrado") with native tall grasses or invaded by *Melinis minutiflora* (São Paulo, Brazil).

147. Deciduous broadleaf scrub seasonal tallgrass savanna.

Ex.: tallgrass prairie with scattered *Ceanothus* (Mississippi Valley, U.S.A.).

B. Fern types**148. Scrub-Espeletia evergreen tallfern savanna.**

Ex.: open phases of medium-tall *Espeletia hartwegiana* with closed layer of *Blechnum schomburgkii* (Páramo de San Rafael, Cauca, Colombia). This may also be called "rosette-scrub evergreen tallfern savanna".

XX. SCRUB SHORT SAVANNA**A. Grass types****149. Evergreen broadleaf scrub evergreen shortgrass savanna.**

Ex.: grassy phases of subalpine scrub (Hawaiian volcanoes); many areas of grassland with scattered low shrubs and subshrubs in humid Tropics and Subtropics, such as some forms of "campo" in southern Brazil; *Sophora-Myoporum* savanna (high altitudes, Hawaii).

150. Evergreen broadleaf scrub seasonal shortgrass savanna.

Ex.: many areas of natural savanna in northern South America; grass with scattered sagebrush (*Artemisia tridentata*) (western U.S.A.); many areas of grassland with scattered low shrubs and subshrubs in humid Tropics with mild dry season, such as some forms of "campo" in southern Brazil; open phases of tola (*Lepidophyllum*) heath (Peru, Bolivia); *Sida-Lepturus* savanna (Pacific coral islands).

151. Scrub-conifer seasonal shortgrass savanna.

Ex.: *Juniperus communis* savanna (North Temperate Zone); old fields with young *Pinus strobus*, succession to forest (northeastern U.S.A.).

152. Scrub-casuarina seasonal shortgrass savanna.

Ex.: early stages of *Casuarina equisetifolia* savanna (Guam).

153. Scrub-palm seasonal shortgrass savanna.

Ex.: desert grasslands with scattered *Chamaerops* (North Africa); natural form or successional stage after disturbance in some areas in semi-dry Tropics, especially when burned regularly.

154. Scrub tree-fern evergreen shortgrass savanna.

Ex.: cleared superhumid forest, now burned and grazed grass and sedge savanna with scattered low tree-ferns resistant to fire (Serra do Mar summit near Paranapiacaba, São Paulo, Brazil).

155. Scrub-yucca seasonal shortgrass savanna.

Ex.: desert grassland with *Yucca alata* or *Y. brevifolia* (southwestern U.S.A.); shortgrass plains with scattered *Yucca glauca* (Great Plains, U.S.A.); *Yucca macrocarpa* scattered over *Bouteloua gracilis*-*B. hirsuta*-*B. eriopoda* shortgrass sod on south-facing slopes (southwestern Texas).

156. Yucca, cactus and aphyllous scrub seasonal shortgrass savanna.

Ex.: *Yucca alata*, *Opuntia lindheimeri*, *O. macrocentra*, and *Koberlinia spinosa* scattered in shortgrass flats of *Bouteloua gracilis*, *B. hirsuta* and *B. eriopoda* (southwestern Texas).

157. Scrub-lobelia evergreen shortgrass savanna.

Ex.: scattered *Lobelia bequaertii* in *Carex runssorensis* bog (Mt. Ruwenzori, Uganda).

158. Scrub-senecio evergreen shortgrass savanna.

Ex.: scattered *Senecio cottonii* along valley of small stream (Mt. Kilimanjaro, Tanganyika). 158 and 157 could also be called "scrub rosette-tree evergreen shortgrass savanna".

159. Scrub-cactus seasonal shortgrass savanna.

Ex.: desert grassland with *Opuntia* (southwestern U.S.A.); midgrass prairie with *Opuntia arborescens* (Colorado, U.S.A.).

160. Nolina seasonal shortgrass savanna.

Ex.: scattered sessile clumps of *Nolina texana* on *Bouteloua gracilis*-*B. hirsuta* shortgrass flats (southwestern Texas).

161. Cushion scrub seasonal shortgrass savanna.

Ex.: *Azorella* "puna" (Bolivia, Chile); cushion-*Opuntia* "puna" (Peru).

162. Semideciduous broadleaf scrub seasonal shortgrass savanna.

Ex.: open low phases of "cerrado" (also called "campo cerrado" or "campo sujo") (Central Brazil).

163. Deciduous broadleaf scrub seasonal shortgrass savanna.

Ex.: early stages of forest succession on old fields where pine is absent (eastern U.S.A.); pastures with scattered low *Crataegus* (eastern U.S.A.); *Acacia* savanna (Caribbean, Andes); many areas of grassland or sedge meadow with scattered low shrubs and subshrubs in temperate or arctic regions or in tropical regions with dry season; open phases of *Ulmus pumila* scrub (Central Asia); mesquite (*Prosopis*) grassland (Texas, New Mexico); plagioclimax moor (*Molina caerulea* in thin peat, invaded by *Betula* and *Salix capraea* shrubs (Derbyshire, England); "seridó" variety of "caatinga" (southwestern Rio Grande do Norte, northwestern Paraíba, and northern Bahia along the Rio São Francisco, Brazil).

B. Herb types

164. Evergreen broadleaf scrub evergreen shorter herb savanna.

Ex.: many areas of heavily grazed pasture on wet soil in humid Tropics.

165. Deciduous broadleaf and succulent scrub seasonal shorter herb savanna.

Ex.: semi-desert of *Euphorbia tirucalli*, *E. heterocoma*, *Acacia*, *Salvadora*, *Gymnosporia*, *Cissus*, *Pyrenacantha malvifolia*, *Adenia globosa*, etc. (East Africa).

C. Mixed grass and herb types

166. Deciduous broadleaf scrub seasonal short grass and herb savanna.

Ex.: scattered *Zizyphus lotus* in herb-grassland (Upper Galilee, Palestine).

D. Moss types

167. Scrub-conifer moss savanna.

Ex.: moss field with scattered young conifers becoming established (southern Appalachian Mountains, U.S.A.); sphagnum bogs with scattered young *Abies* or *Larix* becoming established (eastern North America).

XXI. SPARSE WOODLAND

168. Evergreen broadleaf sparse woodland.

Ex.: *Parkinsonia* desert (Arizona, Peru); *Olneya* desert (Arizona).

169. Tree-cactus sparse woodland.

Ex.: phases of *Cereus giganteus* desert with negligible shrubby layer (Arizona).

170. Deciduous broadleaf sparse woodland.

Ex.: *Idria* desert (Baja California); *Prosopis* desert (Arizona, Peru).

XXII. TREE AND SCRUB SPARSE WOODLAND

(Many natural desert areas are of this type, as well as some communities on rock pavements and rocky talus slopes in more humid areas; also cut-over forest or woodland remnants with highly eroded soil bearing a sparse or absent herbaceous layer.)

171. Deciduous broadleaf tree and scrub sparse woodland.

Ex.: Fringing vegetation of a wadi, with *Acacia* trees and *Withania* and *Lycium* shrubs. Herbaceous layer absent, having been completely grazed out (Arabia).

XXIII. SPARSE SCRUB**172. Evergreen broadleaf sparse scrub.**

Ex.: over 1/2 m tall: *Capparis* desert (Peru); *Larrea-Franseria* desert (southwestern U.S.A.); sparse phases of sagebrush (*Artemisia tridentata*) (Great Basin, U.S.A.); scattered scrub of *Calliandra angustifolia* with trunkless spreading crowns up to 1 m tall (on island of deposited small stones in Sucumbíos River, Colombia); *Suaeda-Zygophyllum* desert (Arabia); *Tamarix* desert (Arabia); *Halyoxylon persicum* desert (Arava Valley, Palestine); phase of "vasante" vegetation on river valley floor (near Januária, Minas Gerais, Brazil);

dwarf forms (less than 1/2 m tall): *Varthemia iphionoides* desert (Judean Desert, Palestine); *Artemisia herbae-albae* desert (Negev, Palestine); *Zygophyllum dumosum* hammada desert (Negev, Palestine); *Suaeda asphaltica* gypsum desert (Judean Desert, Palestine); *Atriplex* flats (southwestern U.S.A.); alkali flats with *Allenrolfea*, *Sarcobatus*, *Suaeda*, *Atriplex* (Death Valley, California); shadscale (*Atriplex confertifolia*) desert (Nevada).

173. Aphyllous sparse scrub.

Ex.: *Koeberlinia* desert (New Mexico).

174. Sparse palm scrub.

Ex.: *Phoenix arabica* desert (Arabia).

175. Sparse Welwitschia scrub.

Ex.: *Welwitschia* desert (Southwest Africa).

176. Sparse cactus scrub.

Ex.: *Opuntia fulgida* desert (Arizona); cholla (*Opuntia*) desert (Mohave Desert, southwestern U.S.A.).

177. Sparse cactoid-euphorbia scrub.

Ex.: *Euphorbia ammak* on granite rock-strewn slopes (Arabia).

178. Deciduous broadleaf sparse scrub.

Ex.: (all these more than 1/2 m tall): dry sparse "caatinga" near Jatina (now Belém do São Francisco), Pernambuco, Brazil; sparse phases of *Pentzia-Rhigozum* scrub (South Africa); *Fouquieria-Acacia greggii* desert (southwestern U.S.A.); *Acacia constricta* desert (New Mexico, U.S.A.); medium-tall *Acacia*

shrubs on rock-strewn slopes (Arabia); "*Rhanterium* steppe", low scattered shrubs of *R. eppaposum* (Arabia).

XXIV. TALLPLANT FIELD

A. Non-tussock grass types

179. Evergreen tallgrass field.

Ex.: drained sites: *Panicum purpurascens* and *P. maximum* stands (Pacific Islands); *Miscanthus floridulus* stands, where not seasonally brown (Western Pacific); "sapèzal" (*Imperata brasiliensis*) stands (southern Brazil);

bog and marsh sites: tropical tall *Eleocharis* marshes; tropical *Typha* marshes; *Mariscus* marsh (Everglades, Florida); *Cyperus giganteus* marsh (Brazil); *Cyperus papyrus* marsh (Africa); *Phragmites karka* swamp (Pacific); *Scirpus* marsh (Tropics); grass and sedge "campos de várzea" (Amazon);

floating grass fields 1 m or more tall: "gramalote" (Amazon).

180. Seasonal tallgrass field.

Ex.: drained sites: tallgrass prairie (Mississippi Valley, U.S.A.); high veldt (*Themeda*) (Transvaal, South Africa); *Miscanthus floridulus* in areas with dry season (Western Pacific); *Themeda* stands (Western Pacific);

marsh sites: tall salt marsh (Temperate Atlantic coasts); *Typha* marshes (Temperate Zone); tall sedge meadows and marshes when without prominent tussock aspect (Temperate Zone);

floating grass fields: *Typha* mats over water surface (North Temperate Zone);

submerged sites: taller phases of eelgrass stands (*Zostera*) (Temperate Atlantic coasts).

B. Tussock grass types (with prominent permanent stools)

181. Evergreen tall tussock-grass field.

Ex.: closed and open phases of *Poa cespitosa*-*Danthonia nudiflora* snow tussock grassland (southeastern Australian mountains); closed and open phases of snow tussock (*Danthonia*) (New Zealand); fields of *Poa flabellata* or of *Spartina arundinacea* (Gough Island, South Atlantic); *Saccharum spontaneum* stands (Western Pacific); taller phases of *Festuca* tussock (New Zealand).

182. Seasonal tall tussock-grass field.

Ex.: some aspects of "steppe" (southwestern Asia & southern Russia); many sedge marshes in temperate zone.

C. Herb Types

183. Evergreen tallherb field.

Ex.: drained sites: pioneer weedy vegetation after clearing (humid Tropics); taller phases of broad-leaved herb vegetation on permanently disturbed waste ground in cities (humid Tropics);

marsh sites: taro (*Colocasia*) marsh (Pacific Islands); *Hedychium coronarium* marsh (southern Brazil); *Thalia geniculata* marsh (Vera Cruz, Mexico); pure *Heliconia bihai* stand outside of forest border (Vera Cruz, Mexico).

submerged herb fields: canal vegetation (Thailand). The height of the herbs depends on the depth of the water.

184. Seasonal tallherb field

Ex.: drained sites: pioneer vegetation in abandoned fields on moist rich soil (humid Temperate Zone, particularly where not grazed); natural meadows (Kamchatka); the gigantic, tree-like Umbelliferae in Kamchatka meadows form a vegetation that could be called "seasonal giant herb field";

marsh sites: broad-leaved herb marshes (Temperate Zone);

submerged herb fields (or in estuaries, periodically submerged): tall *Potamogeton* stands (North Temperate Zone); *Nymphaea* and *Nuphar* marshes (North Temperate Zone).

D. Mixed grass & herb types**185. Evergreen tall grass and herb field.**

Ex.: *Almisia longifolia*-*Poa cespitosa* tall alpine herbfield (southeastern Australian mountains).

186. Seasonal tall grass and herb field.

Ex.: many meadows and tallgrass prairies in humid temperate zone when flowering forbs are prominent.

E. Fern types**187. Evergreen tallfern field.**

Ex.: *Gleichenia* sward (Tropics); *Nephrolepis* meadow (Western Pacific); *Blechnum* marsh (cleared areas in Serra do Mar and on swampy "restinga" sands, coastal plain of southern Brazil); bracken (*Pteridium*) stands (some cleared forest areas, southern Brazil).

F. Seaweed types**188. Tall seaweed field.**

Ex.: submerged kelp and other seaweed stands when dense.

XXV. SHORTPLANT FIELD**A. Non-tussock grass types****189. Evergreen shortgrass field.**

Ex.: drained sites: "lalang" (*Imperata cylindrica*) (Malaysia); heavily grazed, predominantly graminoid, natural or artificial pastures on permanently moist ground in Tropics; many areas of beach and dune grass in humid Tropics.

bog and marsh sites: *Oreobolus* bog (New Zealand); tropical low *Eleocharis* marshes and marshes of other low sedges;

floating grass fields (less than 1 m tall above water surface); canarana (*Echinochloa spectabilis*) mats on river edges (Brazil).

190. Seasonal shortgrass field.

Ex.: drained sites: "patna" (Ceylon); midgrass prairies and shortgrass plains (western Mississippi Valley, U.S.A.); drained grass and sedge tundras; most humid temperate zone pastures; phases of "puna" (middle Andes); *Danthonia* grassy "balds" (southern Appalachian Mountains, U.S.A.); desert grassland (southwestern U.S.A.); *Cenchrus-Lepturus* grassland (Canton Island and other dry coral islands); beach and dune grass stands in Temperate Zone; local areas of "campo limpo" form of "cerrado" (Campos de Vacaria, etc., Brazil);

marsh and bog sites: low phases of saltmarsh (Temperate Zone); lower phases of sedge marshes (Temperate Zone); marshy grass and sedge tundras; floating grass fields (less than 1 m tall above water surface); quaking sedge bogs (Temperate and Subarctic Zones);

submerged grass fields: lower phases of eelgrass stands (*Zostera*) (Temperate Atlantic coasts); *Vallisneria* stands (North Temperate Zone).

191. Ephemeral shortgrass field.

Ex.: ephemeral grass stands in desert areas; sedge and grass tundra covered with snow more than nine months of the year. For at least part of the year, these must have a herbaceous cover of 10% or more.

B. Tussock-grass types

192. Evergreen short tussock-grass field.

Ex.: lower phases of *Festuca* tussock (New Zealand); *Chionochloa rigida* tussock (New Zealand).

193. Evergreen short tussock-grass and cushion-herb field.

Ex.: scattered tussocks of *Chionochloa rigida* in dense low cushion-herb mat (Old Man Range, Otago, New Zealand).

194. Seasonal short tussock-grass field.

Ex.: many areas of marsh in temperate zone; phases of "puna" (Peru).

C. Herb types

195. Evergreen shortherb field.

Ex.: drained sites: lower broad-leaved herb phases of permanently disturbed waste ground vegetation in cities (humid Tropics and Subtropics); alpine herb fields (Tropics); denser phases of herbaceous *Atriplex* stands (Australia, Hawaii); denser phases of *Suaeda* flats (coastal or alkaline sand flats, Africa, Thailand, New Mexico, etc.); denser phases of *Portulaca* stands (Marshall Islands); denser phases of beach and dune vegetation dominated by *Ipomoea* and other broad-leaved herbs (Tropics); denser phases of *Salicornia* flats (Tropics and Subtropics);

floating herb fields (less than 1 m tall above water surface); denser phases of *Eichhornia*, *Pistia*, *Salvinia*, *Azolla*, *Lemna*, etc., stands;

submerged herb fields: *Najas* masses in canals and streams (Tropics); lower phases of submerged broadleaved herbs (canal vegetation, southeastern Asia).

196. Seasonal shortherb field.

Ex.: drained sites: *Trollius* meadows (Lapland); broadleaved herb phases of pioneer vegetation on old fields, waste ground, and newly deposited soil material, when less than 1 m tall (Temperate Zone; Tropics with dry season); alpine herb fields (Temperate Zone); denser phases of *Salicornia* flats (Temperate coasts and inland saline areas); overgrazed *Hilaria mutica* shortgrass flats invaded by *Gutierrezia texana* and *G. divaricata* (southwestern Texas).

marsh sites: broadleaved herb marshes (Temperate Zone);

floating herb fields (less than 1 m tall above water surface); denser phases of *Lemna*, *Azolla*, etc. (Temperate Zone).

submerged herb fields: low *Potamogeton* stands and *Najas* stands (North Temperate Zone).

197. Ephemeral shorterb field.

Ex.: *Abronia*, *Eschscholtzia*, *Astragalus* and other ephemeral flower displays on sandy areas in desert (southwestern U.S.A.); "loma" vegetation (Peru); broadleaved herb tundras covered by snow more than nine months of the year. For at least part of the year, these must have a herbaceous cover of 10% or more.

D. Cushion-herb types**198. Cushion-herb field.**

Ex.: *Pycnophyllum* "puna" (Bolivia); *Raoulia* stands (New Zealand).

E. Mixed grass & herb types**199. Evergreen short grass and herb field.**

Ex.: many areas of beach and dune vegetation in Humid Tropics.

200. Seasonal short grass and herb field.

Ex.: phases of "vasante" on river valley floor (near Januária, Minas Gerais, Brazil).

F. Mixed grass & cushion-herb types**201. Evergreen short grass and cushion-herb field.**

Ex.: *Plantago rigida* polsters with tufts of *Calamagrostis effusa* ("páramo", Nevada de Ruiz, Cordillera Central, Colombia); marsh with low pads of *Distichia tolimensis* separated by short *Calamagrostis* sp. (Nevada del Cocuy, Cordillera Oriental, Colombia).

G. Mixed grass & fern types**202. Seasonal short grass and fern field.**

Ex.: bracken grassland (*Pteridium* and grasses) (Wisconsin, U.S.A.).

H. Moss types**203. Moss field (or moss mat).**

Ex.: moss mats on stone ledges, rock pavements, sand barrens, etc.; *Polytrichum* mats on acid-soil fields (northeastern U.S.A.); sphagnum bogs.

I. Mixed moss & lichen types**204. Moss and lichen field (or moss and lichen mat).**

Ex.: mixed moss and lichen mats on rock pavements; *Polytrichum-Cladonia* mats on acid-soil fields (northeastern U.S.A.).

205. Lichen field (or lichen mat).

Ex.: lichen mats on stone ledges and rock pavements; *Cladonia* tundras.

K. Seaweed types**206. Short seaweed field (or seaweed mat).**

Ex.: submerged dense seaweed stands less than 1 m tall; *Fucus* mats on wave-washed rocks.

L. Microscopic alga or Characeae types**207. Alga mat.**

Ex.: thick floating (or occasionally stranded) masses of *Spirogyra*, *Zygnema*, *Cladophora*, *Chara*, *Nitella*, etc., on freshwater ponds, tidal pools,

etc. (Permanent, seasonal or periodic, or erratic types may be distinguished if desired).

XXVI. SPARSE FIELD
(never reaching 10% cover)

A. Grass types

208. **Evergreen sparse grass field.**

Ex.: *Cyperus conglomeratus* desert (Arabia); *Agrostis nigritella* clumps scattered over bare sand bathed by glacial water ("superpáramo", Nevada de Cocuy, Cordillera Oriental, Colombia).

209. **Seasonal sparse grass field.**

Ex.: *Aristida* desert where shrubs are lacking (South Africa); Trans-Caspian Desert; Gobi Desert; sparse phases of desert grassland due to overgrazing (southwestern U.S.A.); sparse phases of beachgrass (*Ammophila*) on upper beach and dunes (North Temperate Zone).

210. **Ephemeral sparse grass field.**

Ex.: sparse phases of predominantly graminoid vegetation in some areas of desert and in tundras covered by snow for more than nine months of the year.

B. Herb types

211. **Evergreen sparse herb field.**

Ex.: drained sites: scattered *Senecio* spp. on sandy hillsides ("superpáramo" formation. Páramo del Almorzadero, Cordillera Oriental, Colombia); scattered herbs in clefts of rock pavements and on lateritic crusts in warm humid regions; early pioneer stages on newly deposited soil material or on completely cleared soils in warm humid regions; Karroo Desert vegetation (South Africa); sparse phases of *Salicornia* flats (Tropics);

floating herb fields: scattered *Pistia* at junction of waters of the Rios Negro and Solimões to form the Amazon, near Manaus, Brazil.

212. **Seasonal sparse herb field.**

Ex.: scattered herbs in clefts of rock pavements in temperate regions; early pioneer stages on newly deposited soil material or completely cleared soils in temperate regions; sparse phases of *Salicornia* flats (Temperate Zone).

213. **Ephemeral sparse herb field.**

Ex.: some areas in deserts, and in tundras covered by snow more than nine months of the year.

C. Cushion-herb types

214. **Sparse cushion-herb field.**

Ex.: scattered *Haastia pulvinaris* on stone fields (Mt. Tarndale, New Zealand).

D. Mixed types

215. **Evergreen sparse herb, grass and cushion-herb field.**

Ex.: *Arenaria bryoides*, *Draba pringlei*, *Erysimum macradenium* and *Calamagrostis tolucensis* in crater of Nevado de Toluca, Mexico, at 4300 m.

E. Moss types, lichen types

216. **Sparse moss field; sparse lichen field; sparse moss and lichen field.**

Ex.: alpine and polar fell fields, rock pavements in temperate zone with beginning of xerosere.

APPENDIX

Optional Criteria

The criteria used in the previous part of this paper are all that are employed to form the vegetation forms in the main list. Anymore (with the exception, in some cases, of scrub heights) would unduly lengthen the expressions. However, if a short description rather than a name is wanted, a number of optional criteria may be included which will more specifically characterize the aspect of the stand.

Recommended ones with suggested class limits and terminology are as follows.

1. *Tree height*: *tall*, more than 20 m; *medium-tall*, more than 7 m & up to 20 m. (*Low*, 3-7 m *tall*, is already included among the main criteria.)

2. *Scrub height*: *tall*, over 3 m; *medium-tall*, over 1 1/2 m & up to 3 m; *low*, 1/2 - 1 1/2 m; *dwarf*, less than 1/2 m. When varying heights are present *that are prominent in the contour of the vegetation*, these can be specified as "low to tall", "dwarf to low", etc., or simply as "uneven".

3. *Thorniness*: "thorn forest", "thorn scrub", etc., if predominantly so.

4. *Gnarledness*: "gnarled low forest", "gnarled scrub", "gnarled scrub savanna", etc., if predominantly so. I have used this criterion in the main list only in the extreme case of a krummholz where it may properly be considered a kind of growth form.

5. *Leaf texture*: *sclerophyll*, if the mass of the vegetation is decidedly of this type; *semi-sclerophyll*, if a definitely noticeable part of the vegetation is non-sclerophyll and a definitely noticeable part is decidedly sclerophyll. Thus, "evergreen broadleaf sclerophyll closed scrub", "semideciduous gnarled semi-sclerophyll scrub seasonal shortgrass savanna", etc.

6. *Presence of lianas*. "Liana" was already given as growth form for use when it makes up all or a principal part of the stand. When it is conspicuously present but a relatively minor structural component in a forest or woodland (as it is, for instance, in many rainforests), the expression "... with lianas" may be added at the end.

7. *Presence of epiphytes*. When vascular or non-vascular epiphytes are very prominent, covering large areas of trunks and boughs, one may add at the end, "... with vascular epiphytes", "... with epiphytic bryophytes", "... with epiphytic lichens", etc.

8. *Open ground*. If desired, woodlands, open scrubs, savannas, and tall-plant and shortplant fields that have an open herbaceous layer may be distinguished from those that have a closed herbaceous layer by adding to the former, "... with open ground" at the end of expression.

9. *Degree of disturbance*. For trees and scrub elements; *virgin*; *primary* (general appearance of primary vegetation but not sure that it is really virgin); *high-graded primary* (up to 20% of the larger trees removed); *partially-burnt primary*; *partially cleared primary* (20-80% of original trees left and no appreciable number of secondary trees yet grown); *cleared primary with scattered original trees* (less than 20% of original trees left and no appreciable number of secondary trees yet grown) (the last two may be "forests" no longer, but

lowlandlands"); *mixed primary-secondary* (more than 20% of original trees left, intermixed with secondary trees); *secondary forest (or secondary closed* 'eft, intermixed with *secondary* trees); *secondary forest (or secondary closed scrub)* with scattered original trees (less than 20% of original trees left); *secondary*; *high-graded secondary* (up to 20% of the larger trees removed); *partially burnt secondary*; *partially cleared secondary*; *lightly grazed*; *heavily grazed*; etc.

For the herbaceous layer in savannas, sparse woodlands, sparse scrubs, and fields: *virgin* (i.e., never plowed or cultivated); *secondary* (after having been at least once plowed or cultivated); *recently burned*; *periodically burned*; *lightly grazed*; *heavily grazed*; *eroded*; etc. Mixtures of cultivation, burning, grazing and erosion can also be mentioned.

If the primitive state of the stand is known and is different from the present state, the primitive state may be added in parentheses at the end preceded by "primitively..." or "originally..."

10. *Detailed terms for seasonality of the herbaceous layer.* When the herbaceous cover is ephemeral no further qualification as to its seasonality is necessary. "Ephemeral tallplant field", "ephemeral lowplant field", and "ephemeral sparse field" express all that is necessary for the gross categories of the present system. However, when the herbaceous cover is evergreen or seasonal a more detailed terminology may be desired to express more exactly what is happening. There are two aspects of seasonality of the herbaceous layer, (1) change in total ground cover during the year, and (2) change in the proportion of the cover existing at any time that is green (or some other color) and can be supposed to be alive, the rest of the cover having died on the stem (and so yellow or brown) but still visible as organized plant bodies. Thus, in a warm region with a short dry season, a stand may have a closed herbaceous layer that remains closed the whole year but in the dry season 20% of it yellows or dries up and turns brown. In a warm region with a long dry season the herbaceous layer may vary from closed and all green in the wet season to sparse in the dry season, with the sparse cover at this season being, say, 30% green and 70% yellow or dried-up and brown. A temperate humid meadow or pasture may have a closed all-green herbaceous layer in the summer, the same closed layer 60% green and the rest yellow or brown just after the first frosts, and a sparse cover that is all-green in winter. In this case, the part of the cover that disappeared already had rotted away by midwinter, leaving bare soil in its stead, while the remaining cover consists of evergreen basal rosettes of the perennial herbs, etc.

In the following list, "grass field" is used in the examples, but "herb field", "grass and herb field", etc., would be used where appropriate. The same classification can be used for the herbaceous layer in savannas. The assumption is made, of course, that in the favorable season the cover is all-green. The second part of the expression, in those cases where the cover, height or color changes during the year, represents the *greatest* change in each that occurs in the stand during the year.

I. Cover closed or open in favorable season.

A. Cover remains closed or open (i.e., does not become sparse or absent) during the whole year.

1. Tall cover remains tall.
 - a. Evergreen tallgrass field.
 - b. Tallgrass field, seasonally semi-green.
 - c. Tallgrass field, seasonally non-green.
2. Tall cover seasonally becomes short (i.e., grass and herb stems die down and only the bases remain, or short species appear).
 - a. Evergreen tallgrass field, seasonally short.
 - b. Tallgrass field, seasonally short and semi-green.
 - c. Tallgrass field, seasonally short and non-green.
3. Short cover all year.
 - a. Evergreen shortgrass field.
 - b. Shortgrass field, seasonally semi-green.
 - c. Shortgrass field, seasonally non-green.

B. Cover becomes sparse during the unfavorable season.

1. Tall cover remains tall.
 - a. Evergreen tallgrass field, seasonally sparse.
 - b. Tallgrass field, seasonally sparse and semi-green.
 - c. Tallgrass field, seasonally sparse and non-green.
2. Tall cover seasonally becomes short.
 - a. Evergreen tallgrass field, seasonally sparse and short.
 - b. Tallgrass field, seasonally sparse, short and semi-green.
 - c. Tallgrass field, seasonally sparse, short and non-green.
3. Short cover all year.
 - a. Evergreen shortgrass field, seasonally sparse.
 - b. Shortgrass field, seasonally sparse and semi-green.
 - c. Shortgrass field, seasonally sparse and non-green.

C. Cover disappears during the unfavorable season.

1. Tall cover in favorable season.
 - a. Tallgrass field, vegetation seasonally absent.
(For savannas: "... tallgrass savanna, herbaceous layer seasonally absent", etc.)
2. Short cover in favorable season.
 - a. Shortgrass field, vegetation seasonally absent.
(For savannas: "... shortgrass savanna, herbaceous layer seasonally absent", etc.)

II. Cover sparse in favorable season.

- A. Cover remains sparse during the whole year.**
 - a. Evergreen sparse grass field.
 - b. Sparse grass field, seasonally semi-green.
 - c. Sparse grass field, seasonally non-green.
- B. Cover disappears during unfavorable season.**
 - a. Sparse grass field, vegetation seasonally absent.
(For sparse woodlands and scrubs: "... sparse woodland, herbaceous layer seasonally absent", etc.)

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REFERENCES

- AZEVEDO**, Luiz Guimarães de. 1962. Tipos de vegetação do Sul de Minas e Campos de Mantiqueira (Brasil). *Anais Acad. bras. Ciênc.*, Rio de Janeiro, **34**: 225-234.
- . 1966 [1967]. Tipos eco-fisionômicos de vegetação da região de Januária (Minas Gerais). *Anais Acad. bras. Ciênc.*, Rio de Janeiro, **38** (suppl.): 39-57.
- BARNARD**, C., ed. 1964. *Grasses and grasslands*. London, Macmillan. 269 p., illus.
- BEARD**, J. S. 1953. The savanna vegetation of northern tropical America. *Ecol. Monogr.*, Durham, N. C., **23**: 149-215.
- BURTT**, B. D. 1942. Some East African vegetation communities. *J. Ecol.*, London, **30**: 65-146.
- CORNER**, E. J. H. 1966. *The natural history of palms*. London, Weidenfeld & Nicolson, 393 p., 133 fig., 24 pl.
- COSTIN**, A. B. 1959. Vegetation of the high mountains in Australia in relation to land use. *Monogr. Biol.*, **8**: 427-451.
- COTTLE**, H. J. 1931. Studies in the vegetation of southwestern Texas. *Ecology*, Durham, N. C., **12**: 105-155.
- . 1932. Vegetation on north and south slopes of mountains in southwestern Texas. *Ecology*, Durham, N. C., **13**: 121-134.
- CUATRECASAS**, Jose. 1958. Aspectos de la vegetación natural de Colombia. *Revta. Acad. colomb. Cienc. exact. fis. nat.*, Bogotá, **10**: 221-268.
- CURTIS**, John T. 1959. *The vegetation of Wisconsin*. Madison, Wisc., University of Wisconsin Press. 657 p., 53 fig., 66 pl., 35 maps in app.
- DAU**, Leda. 1960. Microclimas das restingas de sudeste do Brasil: I, Restinga interna de Cabo Frio. *Archos Mus. Nac.*, Rio de Janeiro, **50**: 79-134.
- DANSEREAU**, P. 1957. *Biogeography, an ecological perspective*. New York, Ronald Press. 394 p., 122 illus. + 6 illus. in app.
- EYRE**, S. R. 1963. *Vegetation and soils, a World picture*. London, Edward Arnold. 324 p., 30 fig., 22 pl., 10 maps.
- FOSBERG**, F. R. 1961. A classification of vegetation for general purposes. *Bull. int. Soc. trop. Ecol.*, Poona, **2**: 1-28.
- GOOD**, Ronald. 1953. *The geography of the flowering plants*, 2nd ed. London, Longmans, Green. 452 p., 75 fig., 25 pl.
- GRIGGS**, R. F. 1934. The edge of the forest in Alaska and the reasons for its position. *Ecology*, Durham, N. C., **15**: 80-96.
- HEDBERG**, Olov. 1964. Features of afroalpine plant ecology. *Acta phytogeogr. suec.*, Uppsala, **49**: 1-144.
- JENNINGS**, O. F., 1917. A contribution to the botany of the Isle of Pines, Cuba. *Ann. Carneg. Mus.*, Pittsburgh, **11**: 19-290.
- KÜCHLER**, A. W. 1949. A physiognomic classification of vegetation. *Ann. Ass. Am. Geogr.*, Minneapolis, **39**: 201-210.
- . 1950. Die physiognomische Kartierung der Vegetation. *Petermanns geogr. Mitt.*, Gotha, **94**: 1-6.
- LINDMAN**, C. A. M. 1906. *A vegetação no Rio Grande do Sul (Brasil Austral)*, tradução portuguesa por Alberto Löfgren. Porto Alegre, Liv. Universal: 356 p., 69 illus.

- LOVELESS, A. R. & ASPREY, G. F.** 1957. The dry evergreen formations of Jamaica: I, The limestone hills of the south coast, *J. Ecol.*, London, **45**: 799-822.
- MARK, A. F.** 1965. The environment and growth rate of narrowleaved snow tussock, *Chionochloa rigida*, in Otago. *New Zealand J. Bot.*, **3**: 73-103.
- MARTIN, William E.** 1959. The vegetation of Island Beach State Park. *Ecol. Monogr.*, Durham, N. C., **29**: 1-46.
- MIRANDA, F. & HERNÁNDEZ X., E.** 1963. Los tipos de vegetación de México y su clasificación. *Boln Soc. Bot. México*, México, D. F., n.º **28**: 29-179.
- SCHIMPER, A. F. W.** 1903. *Plant geography upon a physiological basis.*, English edition translated by W. R. Fisher, P. Groom & I. B. Balfour. Oxford, Clarendon Press. 839 p., 497 illus., 5 collotypes, 1 frontispiece, 4 folded maps.
- SEGADAS-VIANNA, Fernando.** 1955. Ecological study of the peat bogs of eastern North America: II, The *Chamaedaphne calyculata* community in Quebec and Ontario. *Can. J. Bot.*, Ottawa, **33**: 647-684.
- SMILEY, Nixon,** 1965. Around the world in search of cycads. *Fairchild trop. Gard. Bull.*, Miami, **20**(2).
- STEYERMARK, Julian A.** 1966. Nuestra vegetación. *El Farol* **28**: 6-15.
- TROCHAIN, Jean-L.** 1957. Accord interafricain sur la définition des types de végétation de l'Afrique Tropicale. *Bull. Inst. Étud. centrafr.*, new series, Brazzaville, **13/14**: 55-93.
- VESEY-FITZGERALD, D. F.** 1957. The vegetation of the Red Sea coast north of Jeddah, Saudi Arabia. *J. Ecol.*, London, **45**: 547-562.
- WACE, N. M.** 1961. The vegetation of Gough Island. *Ecol. Monogr.*, Durham, N.C., **31**: 337-367.
- WARDLE, P.** 1965. A comparison of alpine timberlines in New Zealand and North America. *New Zealand J. Bot.*, **3**: 113-135.
- WEBB, L. J.** 1959. A physiognomic classification of Australian rainforest. *J. Ecol.*, London, **47**: 551-570.
- WETTSTEIN, Richard.** 1935. *Handbuch der systematischen Botanik*, 4^{te} ed. Leipzig & Wien, Franz Deuticke. 1149 p., 709 illus., 1 frontispiece.
- ZOHARY, Michael.** 1962. *Plant life of Palestine*. New York, Ronald Press. 262 p., 70 illus.

FORMAS DE VEGETAÇÃO

Uma classificação de trechos de vegetação baseada em estrutura, formas de crescimento dos componentes e periodicidade vegetativa.

(RESUMO)



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São Paulo — SP — Brasil

INTRODUÇÃO

Já há bastante tempo vêm sendo publicadas classificações de vegetação. Em quase todos os sistemas as categorias incluem, implícita ou explicitamente, características do ambiente. Além disso, as classes usadas são geralmente amplas, como savana, floresta, etc. Poucas são as classificações, exclusivamente de vegetação, aplicáveis em qualquer parte do mundo e suficientemente detalhadas a poder-se distinguir *trechos* de fisionomia diferente (KÜCHLER, 1949, 1950; DANSEREAU, 1957, FOSBERG, 1961). KÜCHLER e DANSEREAU designam as categorias por fórmulas enquanto FOSBERG emprega nomes.

O sistema desse último autor, embora muito útil, apresenta certas vantagens. Ele usa vários critérios, como consistência e tamanho de fôlha, difíceis de serem avaliados em um relance. Ademais, apesar da intenção declarada de considerar unicamente a vegetação, FOSBERG inclui categorias como "mata pantanosa", "brejo", "prado flutuante" etc., que implicam determinados ambientes.

O presente trabalho baseia-se no sistema de FOSBERG mas, adota vários critérios diferentes. Ambos caracterizam-se pelo uso de nomes concisos para designar o aspecto puramente visual de trechos de vegetação e oferecem terminologia uniforme. Trechos em qualquer parte do mundo, naturais ou modificados pela ação do homem, podem ser comparados *dentro de um só sistema*. As categorias de um sistema desse tipo podem ser usadas em mapeamento, descrição de paisagem, classificação de *habitats* naturais, etc.

Três são os critérios básicos usados na presente classificação:

- (1) *estrutura*: altura das camadas discriminadas e o espaçamento entre seus componentes;
- (2) *forma de crescimento* dos indivíduos, como por exemplo: árvore latifoliada, palmeira, cacto, graminóide etc.;
- (3) *periodicidade vegetativa*: caducidade das árvores e arbustos, secagem e desaparecimento periódico da camada rasteira, etc.

Tipo, tamanho e consistência das fôlhas não são utilizados. O caso de plantas com fôlhas muito grandes, que emprestam à fisionomia um caráter próprio, é considerado em forma de crescimento. A esclerofilia, embora de importância em Ecologia, quase não contribui no aspecto de uma vegetação vista a pouca distância.

ESTRUTURA

Distinguem-se 26 "categorias estruturais". Seus nomes são ecológicamente neutros; foram propositalmente escolhidos de maneira a não dar idéias de ambiente. Assim, tem-se mata, arvoredó*, savana, arvoredó esparsó, campo, etc., mas não "mata equatorial", "campo de altitude", "deserto", etc.

Primeiro, apresenta-se algumas definições de termos que serão usados nas descrições das categorias.

Árvores

(1) Plantas auto-sustentadas, lenhosas ou semilenhosas, mono-, oligo-, ou policaulescente, 3m de altura ou mais, com tronco único mais ou menos evidente.

(2) Ervas gigantes como a bananeira, com pseudotronco definido, quando de 3m de altura ou mais.

(3) Moitas de bambu, de 3m de altura ou mais.

*Elementos de escrube**

(1) Tôdas as plantas lenhosas e semilenhosas, de menos de 3m de altura, incluindo plantas arboriformes, arbustos, bambu baixo, cipós rasteiros, plantas-roseta com troncos, como *Puya*, *Espeletia*, certas espécies de *Yucca*, *Agave*, etc.

(2) Arbustos bem definidos, (i. é, que se destacam da camada herbácea e que não são arboriformes, podendo ter qualquer altura, mesmo mais de 3m).

(3) Plantas não lenhosas ou com partes aéreas não lenhosas, de qualquer forma e tamanho (mesmo mais de 3m de altura), que não são herbáceas típicas e que não são arboriformes, como cactóides sem tronco, palmeiras e cicadáceas acaulescentes, bromeliáceas terrestres grandes ou *Eryngium* grandes.

Escrube visível

Aquêle que não está, no momento de observação, encoberto por vegetação herbácea e densa.

Emergentes (como substantivo)

Árvores ou elementos de escrube que se projetam destacadamente de um dossel fechado (ou acima do nível geral dos pontos mais altos de um dossel fechado de altura irregular).

Camada herbácea

Graminóides (ciperáceas, juncáceas, gramíneas exceto bambu, etc.), ervas latifoliadas, suculentas muito baixas e não foliosas, briófitas, líquens, algas marinhas e camadas grossas e conspícuas de algas filamentosas microscópicas (mas não plâncton nem películas finas de *Chlorococcum*, *Trentepohlia*, etc.).

* **Arvoredó**, s.m., (como termo técnico em Botânica), mata aberta e de sobosque arbustivo não fechado, i. é, formação de árvores intervaladas e com camadas arbustiva aberta, esparsa ou ausente. Termo equivalente a "woodland" no sentido arbóreo.

* **Escrube**, s.m., (inglês "scrub"), camada de vegetação densa ou rala, constituída de plantas com porte intermediário entre árvores e ervas.

Ver no fim dêste resumo justificação do neologismo.

Grau de cobertura

Proporção de um trecho de chão, substrato ou água, coberta por uma camada de plantas, sendo cada planta considerada no nível de sua maior projeção no plano horizontal:

fechado: cobertura de mais de 60%; em outros termos, os perímetros se superpõem, tocam-se ou são ligeiramente separados;

aberto: cobertura de 10-60%, ou seja, os perímetros são em média desde ligeiramente separados até duas vezes o seu diâmetro médio;

esparso ou espalhado: cobertura de menos de 10%, ou seja, os perímetros são separados por uma distância média superior ao dobro dos seus diâmetros médios.

NOTA: nas categorias em que é preciso considerar a camada herbácea, as definições são baseadas no comportamento da referida camada, durante o ano inteiro. Para uma única visita a um trecho, usa-se o aspecto que a vegetação apresenta no momento da visita e acrescenta-se a estação ou mês, no fim da expressão, entre parênteses.

As 26 categorias estruturais são mutuamente exclusivas. A categoria "mata", por exemplo, *não* inclui "mata baixa" e "mata com emergentes" como casos especiais. Apesar de haver possibilidade de confusão, é necessário usar "mata" sem outras palavras para essa categoria. É realmente uma maneira abreviada para expressar "mata alta ou de altura mediana, sem emergentes". Evidentemente, não se pode usar uma expressão tão longa, principalmente levando-se em consideração a necessidade de expressar também, grau de caducidade e formas de crescimento dos indivíduos.

Do mesmo modo, na lista baixo, "arvoredo" não inclui "arvoredo baixo", "arvoredo esparso", etc., como casos especiais. É uma maneira abreviada para exprimir "arvoredo de densidade aberta, de altura alta ou mediana e de aspecto puramente arbóreo".

A ordem adotada na apresentação das categorias estruturais e das ilustrações é da vegetação mais alta para a mais baixa, e da mais fechada para a mais aberta. Por essa razão, "mata com emergentes" precede "mata", etc.

Lista das Categorias Estruturais

I. **MATA COM EMERGENTES**: conjunto formado de uma camada inferior de mata (como definida em II) e uma camada superior de árvores isoladas e espalhadas, que emergem conspícuamente do dossel fechado e dão uma cobertura total absoluta de menos de 10%.

II. **MATA**: dossel fechado, de árvores, de altura regular ou irregular, com mais de 7m de altura, ou, pelo menos, a parte que excede 7m dá uma cobertura de 10% ou mais e não se destaca abruptamente; além disso, não há emergentes isolados e conspícuos.

III. **MATA BAIXA COM EMERGENTES**: conjunto formado de uma camada inferior de mata baixa (como definida em IV) e de uma camada superior formada: ou de árvores, ou de elementos de escrupe, ou de árvores e elementos de escrupe em conjunto. Os elementos da camada su-

perior são isolados e espalhados e emergem conspícuamente do dossel fechado, dando uma cobertura total absoluta inferior a 10%.

IV. MATA BAIXA: dossel fechado, de árvores, de altura regular ou irregular, entre 3 e 7m; quando existe uma parte excedendo 7m, essa dá menos de 10% de cobertura absoluta e faz parte do dossel geral, não havendo emergentes isolados e conspícuos. Se elementos de escrube contribuem na formação do dossel, o aspecto geral deve ser mais arbóreo do que de escrube.

V. MATA ABERTA COM ESCRUBE FECHADO: superfície de cobertura vegetal formada de duas camadas mais ou menos distintas (raro mais de duas); a camada superior é aberta, composta de árvores e a cobertura absoluta da sua porção que excede 7m é de 10% ou mais; a camada inferior ou é um escrube preenchendo o espaço entre os troncos das árvores da camada superior, quando nesta, as copas das árvores estão totalmente acima do nível do escrube, ou é um escrube preenchendo o espaço entre as copas das árvores, quando estas têm suas copas dentro do nível do escrube.

VI. MATA BAIXA ABERTA COM ESCRUBE FECHADO: igual à categoria V, mas as árvores da camada superior com 3 até 7m de altura; se parte da camada superior excede 7m, a cobertura absoluta dessa parte é inferior a 10%.

VII. ESCRUBE-E-ÁRVORES FECHADO, ALTURA IRREGULAR: árvores e escrube formando, em conjunto, uma cobertura fechada, onde as alturas dos indivíduos formam uma superfície irregular e sinuosa, não se distinguindo camadas definidas; os elementos de escrube são os pontos mais baixos da superfície e as árvores com mais de 7m de altura os pontos mais altos. A porção da cobertura total dada pelo escrube é substancialmente maior do que a porção dada pelas árvores.

VIII. ESCRUBE-E-ÁRVORES-BAIXAS FECHADO, ALTURA IRREGULAR: igual à categoria VII, exceto que os pontos mais altos da superfície são formados por árvores, tôdas com menos de 7m de altura. Árvores com mais de 7m são ausentes ou sem influência importante no aspecto.

IX. ESCRUBE FECHADO COM EMERGENTES: conjunto formado de uma camada inferior de escrube fechado (como definido em X) e de uma camada superior de elementos conspícuamente emergentes, isolados e espalhados; esses emergentes são ou arbóreos, ou elementos de escrube, ou ambos os tipos em conjunto. A cobertura dada pelos emergentes é inferior a 10%.

X. ESCRUBE FECHADO: camada fechada, constituída de elementos de escrube, que formam uma superfície regular ou irregular mas, sem emergentes isolados e conspícuos. Geralmente, um escrube tem menos de 3m de altura mas, se os elementos são de formato definidamente arbustivo, pode ser mais alto. No caso em que os elementos arbustivos de mais de

3m intermisturam-se com árvores baixas, o trecho é um escrube fechado se o aspecto predominante é de escrube; se o aspecto predominante é arbóreo, o trecho é uma mata baixa.

XI. ARVOREDO: "woodland", formação de aspecto predominantemente arbóreo com dossel aberto (10-60% de cobertura) e sobosque arbustivo *não* fechado, isto é, aberto, esparso ou ausente. A altura média da superfície superior do dossel é acima de 7m. Uma camada herbácea pode estar presente ou não.

XII. ARVOREDO BAIXO: igual a XI mas, a altura média da superfície superior do dossel é de 3 a 7m, inclusive; árvores com mais de 7m são ausentes ou não importantes no aspecto.

XIII. ARVOREDO DE ESCRUBE-E-ÁRVORES: formação de aspecto entre arbóreo e de escrube, onde árvores e elementos de escrube formam, em conjunto, uma cobertura aberta (10-60%). Os elementos de escrube podem ser mais baixos, da mesma altura ou mais altos que as árvores. Uma camada herbácea pode estar presente ou não.

XIV. ESCRUBE ABERTO: camada aberta, de altura regular ou irregular, constituída de elementos de escrube. Árvores ausentes ou sem influência no aspecto. Geralmente, um escrube tem menos de 3m de altura mas, se os elementos são de formato definidamente arbustivo, pode ser mais alto. No caso em que os elementos arbustivos altos intermisturam-se com árvores baixas, o trecho deve ter um aspecto mais de escrube do que arbóreo.

XV. SAVANA ALTI-HERBÁCEA ARBÓREA: árvores espalhadas (elementos de escrube ausentes ou não conspícuos) e uma camada herbácea viva ou seca mas, ainda visível e não desfeita, que durante 3 meses ou mais no ano, dá uma cobertura de 10% ou mais. Em alguma época do ano, uma cobertura de pelo menos 10% absoluto da camada herbácea atinge ou ultrapassa 1m de altura.

XVI. SAVANA CURTI-HERBÁCEA ARBÓREA: árvores espalhadas (elementos de escrube ausentes ou não conspícuos) e uma camada herbácea viva ou seca mas, ainda visível e não desfeita, que durante 3 meses ou mais no ano, dá uma cobertura de 10% ou mais. Toda a camada herbácea permanece inferior a 1m ou somente menos de 10% de cobertura absoluta atinge ou ultrapassa essa altura.

XVII. SAVANA ALTI-HERBÁCEA COM ESCRUBE-E-ÁRVORES: árvores e elementos de escrube espalhados e igualmente conspícuos, dando um total de cobertura inferior a 10% e uma camada herbácea como em XV.

XVIII. SAVANA CURTI-HERBÁCEA COM ESCRUBE-E-ÁRVORES: árvores e elementos de escrube como em XVII e uma camada herbácea como em XVI.

XIX. SAVANA-ALTI-HERBÁCEA COM ESCRUBE: elementos de escrube esparsos e espalhados (árvores ausentes ou sem influência no aspecto) e uma camada herbácea como em XV.

XX. SAVANA CURTI-HERBÁCEA COM ESCRUBE: elementos de escrube como em XIX e uma camada herbácea como em XVI.

XXI. ARVOREDO ESPARSO: árvores espalhadas (elementos de escrube ausentes ou não conspícuos) e uma camada herbácea que, por mais de 9 meses no ano, dá uma cobertura de menos de 10%. Esta porcentagem inclui o caso de 0%, isto é, ausência da camada herbácea, condição que pode permanecer todo aquele período ou parte dele. (O arvoredo esparsos é semelhante a uma "savana arbórea". Entretanto, a camada herbácea dá sempre menos de 10% de cobertura ou, se atinge ou ultrapassa essa porcentagem, é só por menos de 3 meses.)

XXII. ARVOREDO ESPARSO DE ESCRUBE-E-ÁRVORES: árvores e elementos de escrube espalhados e igualmente conspícuos, com uma cobertura total inferior a 10% e uma camada herbácea como em XXI. (Esta categoria é semelhante a uma "savana com escrube-e-árvores" e com a mesma exceção em referência à camada herbácea, mencionada em XXI.)

XXIII. ESCRUBE ESPARSO: elementos de escrube espalhados (árvores ausentes ou sem influência no aspecto) e uma camada herbácea como em XXI. (Esta categoria é semelhante a uma "savana com escrube" com a mesma exceção mencionada em XXI referente à camada herbácea.)

XXIV. CAMPO ALTI-HERBÁCEO: árvores e elementos de escrube ausentes ou não conspícuos. O trecho é constituído de uma camada herbácea, que no decorrer do ano, atinge ou ultrapassa 10% de cobertura. Pelo menos 10% absoluto da camada herbácea deve atingir ou ultrapassar 1m de altura em alguma época do ano.

XXV. CAMPO CURTI-HERBÁCEO: árvores e elementos de escrube ausentes ou não conspícuos. O trecho é formado de uma camada herbácea, que no decorrer do ano, atinge ou ultrapassa 10% de cobertura. Menos de 10% de cobertura absoluta da camada herbácea atinge ou ultrapassa 1m de altura.

XXVI. CAMPO ESPARSO: árvores e elementos de escrube ausentes ou não conspícuos. O trecho é constituído de uma camada herbácea esparsa de qualquer altura, que nunca ultrapassa 10% de cobertura durante o ano.

Nota-se que a distinção entre "mata" e "mata baixa" não é estabelecida por um único nível de altura. A altura que em geral separa as duas formas é 7m. Mas, se o dossel é, por exemplo, de 6m, uma ou algumas copas excedendo 7m não irão transformar "mata baixa" em "mata". É preciso que uma certa proporção do dossel exceda 7m, mas essa proporção pode ser bem menor que a metade e ainda dar ao dossel aspecto de mais de 7m de altura. Tornando-se necessária a escolha de alguma proporção, 10% foi a escolhida. Se a parte do dossel mais alta que 7m dá uma

cobertura absoluta inferior a 10% e não se destaca conspìcuamente do restante do dossel, o trecho é chamado "mata baixa"; se dá menos de 10% e se destaca abruptamente, é chamado "mata baixa com emergentes"; se a proporção do dossel com mais de 7m tem uma cobertura absoluta superior a 10%, é chamado "mata", destacando-se essa parte, abruptamente ou não.

Considerações semelhantes aplicam-se à distinção entre campo e savana alti-herbáceos e curti-herbáceos.

Nota-se que na distinção entre "elemento de escrube" e "árvore", a altura é considerada somente quando a planta é mais baixa que 3m (escrube) ou mais alta que 7m (árvore). Entre esses limites a planta só é considerada "árvore" quando arboriforme.

FORMAS DE CRESCIMENTO

Classificar as formas de crescimento das plantas é intrinsecamente difícil; conseqüentemente, qualquer sistema que empregue termos sucintos para classificá-las, poderá ser, às vezes, vago, ambíguo ou incorreto. Apresenta-se, entretanto, uma classificação das formas de crescimento *dominantes em vegetação*, usada neste trabalho. A lista está aberta; mais formas poderão ser acrescentadas empregando terminologia semelhante.

Lista de Formas de Crescimento Dominantes em Vegetação

ÁRVORES (3 m ou mais)

latifoliado (i. é, árvores comuns)

conífera

casuarina

palmóide arbóreo, como:

palmeira

cicadácea

feto arborescente

Musa ou bananeira

cactóide arbóreo, como:

cacto arbóreo

eufórbia cactiforme arbórea

cecropióide arbóreo, como:

Cecropia ou imbaúba

Musanga

bambu

paquicaulescente (usado em expressões como "arvoredo paquicaulescente" quando é uma mistura de tipos ou para formas cujo nome é desconhecido)

árvore-roseta, como:

Pandanus

Yucca

Dracaena

Xanthorrhoea

Espeletia

Puya

lobélia arbórea

senécio arbóreo

(usa-se "árvore-roseta" para misturas ou para formas cujo nome é desconhecido) etc.

ELEMENTOS DE ESCRUBE

latifoliado (i. é, arbustos comuns)

conífera (menos de 3m de altura)

casuarina (menos de 3m de altura)

áfilo (i. é, espartóide)

almofadado ("polster", incluindo cacto almofadado, quando de 15cm de altura ou mais)

liana (cipó; usado somente quando essa forma é dominante sobre todas as outras formas no trecho)

bambu (menos de 3m de altura)

aróide gigante (formas grandes com troncos)

Welwitschia

palmóide-escrube, como:

palmeira (acaulescente de qualquer altura, ou palmeira arbórea de menos de 3m de altura; em expressões como "escrube fechado de palmeiras", "savana curti-herbácea com palmeiras-escrube" etc.)

cicadácea (acaulescente de qualquer altura, ou forma arbórea de menos de 3m de altura; usado como "palmeira")

feto arborescente (com tronco e menos de 3 m de altura)

Musa ou bananeira (menos de 3 m de altura)

Ravenala (acaulescente de qualquer altura, ou com tronco e menos de 3 m de altura)

cecropióide-escrube, como:

Cecropia ou imbaúba (menos de 3m de altura)

Musanga (menos de 3 m de altura)

cactóide-escrube, como:

cacto (formas grandes acaulescentes de qualquer altura, quando conspícuos; ou formas com troncos e menos de 3m de altura; em expressões como "escrube fechado de cactos", "savana curti-herbácea com cacto-escrube", etc.)

eufórbia cactiforme (menos de 3m de altura)

estapelióide

escrube suculento (para misturas de tipos ou para uma forma cujo nome não é conhecido)

escrube-roseta (ou quando convém, "planta-roseta"; formas grandes acaulescentes, quando conspícuas; ou formas com troncos e menos de 3m de altura; essa expressão é usada para mistura de tipos ou de um só tipo cujo nome é desconhecido; quando se conhece o nome, usa-se como:

Yucca
 bromélia
Eryngium
Nolina
Vellozia ou canela-de-ema
 lobélia-escrube
 senécio-escrube
Sansevieria
 agave
 Alôe
Espeletia
 etc.

escrube paquicaulescente (como em "arvoredo paquicaulescente de escrube-e-árvores", "savana de escrube paquicaulescente", etc.; menos de 3m de altura; essa expressão é usada para elementos paquicaulescentes cujo nome é desconhecido)

ELEMENTOS HERBÁCEOS

graminoso (i. é, graminóide em geral, de caules separados, ou formando tapetes ou ainda touceiras, sendo que no último caso, as bases das touceiras não aparecem ou não se apresentam altas e bem conspícuas)

gramino-tufoso (graminóides com touceiras de bases permanentes, altas e fortemente conspícuas, quando vistas durante visitas únicas ou quando aparecem assim em alguma época do ano)

erva (i. é, ervas latifoliadas, "forbs", incluindo ervas-roseta, formas pequenas e suculentas como *Portulaca*, *Salicornia*, crassuláceas, plantas-pedra do Deserto de Karroo, etc.)

erva-almofadada ("polster", até 15cm de altura)

feto (acaulescente)

líquen (aspecto dominante ou co-dominante.)

musgo (aspecto dominante ou co-dominante)

alga marinha

tapete algoso (massas grossas de algas filamentosas)

PERIODICIDADE VEGETATIVA

A. Têrmos que se referem ao caráter caducifólio das árvores e arbustos (para expressar informações baseadas em uma só visita).

1. *Todo-verde*: menos de 10% dos indivíduos sem fôlhas.

2. *Semi-verde*: 10-90% dos indivíduos sem fôlhas.

3. *Decíduo*: mais de 90% dos indivíduos sem fôlhas.

Quando os ramos verdes de plantas áfilas caem, devem ser consideradas como se fôsseem fôlhas.

B. Têrmos de periodicidade vegetativa da camada herbácea (para informações baseadas em uma só visita).

1. *Todo-verde*: mais de 90% da camada herbácea existente no momento, viva.

2. *Semi-verde*: 10-90% viva.

3. *Não-verde*: menos de 10% viva.

C. Termos que se referem ao caráter caducifólio das árvores e arbustos (para informações baseadas no comportamento durante o ano todo).

1. *Sempre-verde*: menos de 10% dos indivíduos sem folhas ao mesmo tempo.

2. *Semidecíduo*: usar o que é mais fácil: (a) 10-90% dos indivíduos sem folhas ao mesmo tempo, ou (b) todos, ou quase todos os indivíduos com menos da metade das suas folhas ao mesmo tempo.

3. *Decíduo*: mais de 90% dos indivíduos sem folhas ao mesmo tempo.

D. Termos de periodicidade vegetativa da camada herbácea (para informações baseadas no comportamento durante o ano todo).

1. *Sempre-verde*: mais de 90% da camada herbácea viva e a camada não apreciavelmente diminuída em cobertura durante o ano.

2. *Sazonário*: 10% ou mais da camada herbácea fica amarela ou seca (ou desaparece por algum tempo durante o ano, ou é periodicamente coberta por solo ou por neve, ou levada por correntes d'água). Uma cobertura herbácea viva ou seca mais ainda visível e não desfeita, deve permanecer durante 3 meses ou mais no ano.

3. *Efêmero*: camada herbácea, viva ou morta, visível por menos de 3 meses durante o ano, por qualquer razão.

FORMAS DE VEGETAÇÃO

Na lista seguinte, as formas de vegetação têm números arábicos. Elas são agrupadas sob suas categorias estruturais e marcadas com números romanos, como na lista da pág. 71.

As formas apresentadas não são todas as existentes. Outras formas de crescimento e outras combinações podem ser adicionadas, usando-se terminologia semelhante. Os exemplos de cada forma de vegetação serão encontrados no texto em inglês correspondente, sob o mesmo número.

Para o interesse dos fitogeógrafos brasileiros, as formas de vegetação que, no conhecimento do autor, incluem formas de cerrado no sentido lato, são marcadas com asteriscos. Considera-se (1) cerradão, (2) cerrado no sentido restrito (árvores baixas e densas; arbustos densos), (3) campo cerrado (arvoredos ou escrubes mais abertos; savanas), (4) campo sujo (savana rala arbustiva; florísticamente de cerrado) e (5) campo limpo (quando florísticamente de cerrado, em áreas restritas de substrato ou de drenagem especial, dentro da região geral do cerrado).

I. MATA COM EMERGENTES

1. Mata com emergentes, ambos latifoliados sempre-verdes.

2. Mata latifoliada sempre-verde com coníferas emergentes.

3. Mata com emergentes, ambos latifoliados decíduos.
4. Mata latifoliada decídua com coníferas emergentes.

II. MATA

- * 5. Mata latifoliada sempre-verde.
6. Mata latifoliada sempre-verde com coníferas.
7. Mata latifoliada sempre-verde com coníferas e palmeiras.
8. Mata de coníferas.
9. Mata de casuarinas.
10. Mata de palmeiras.
11. Mata latifoliada sempre-verde com palmeiras.
12. Mata de *Cecropia*.
13. Mata de *Pandanus*.
14. Mata de cactos.
- * 15. Mata latifoliada semidecídua.
16. Mata semidecídua de coníferas.
17. Mata latifoliada decídua.
18. Mata latifoliada decídua com coníferas.
19. Mata de coníferas decíduas.
20. Mata latifoliada decídua com palmeiras.

III. MATA BAIXA COM EMERGENTES

21. Mata baixa com emergentes, ambos latifoliados sempre-verdes.
22. Mata baixa com emergentes, ambos latifoliados decíduos.

IV. MATA BAIXA

23. Mata baixa latifoliada sempre-verde.
24. Mata baixa de senécios arbóreos.
- * 25. Mata baixa latifoliada semidecídua.
26. Mata baixa latifoliada decídua.

V. MATA ABERTA COM ESCRUBE FECHADO

27. Mata aberta com escrube fechado, ambos latifoliados sempre-verdes.
- * 28. Mata aberta latifoliada sempre-verde, com escrube fechado latifoliado decíduo.
- * 29. Mata aberta com escrube fechado, ambos latifoliados semidecíduos.
30. Mata aberta de coníferas, com escrube fechado latifoliado sempre-verde.
31. Mata aberta de coníferas, com escrube fechado latifoliado decíduo.
32. Mata aberta de palmeiras, com escrube fechado latifoliado sempre-verde.
33. Mata aberta de árvores latifoliadas semidecíduas e palmeiras, com escrube fechado de elementos latifoliados decíduos e bambus.
- * 34. Mata aberta com escrube fechado, ambos latifoliados decíduos.
35. Mata aberta latifoliada decídua, com escrube fechado de bromélias.

VI. MATA BAIXA ABERTA COM ESCRUBE FECHADO

- 36. Mata baixa aberta com escrube fechado, ambos latifoliados sempre-verdes.
- 37. Mata baixa de coníferas, com escrube fechado latifoliado decíduo.
- 38. Mata baixa aberta de senécios arbóreos, com escrube fechado latifoliado sempre-verde.
- * 39. Mata baixa aberta com escrube fechado, ambos latifoliados semidecíduos.
- 40. Mata baixa aberta latifoliada decídua, com escrube fechado de cactos.

VII. ESCRUBE-COM-ÁRVORES FECHADO, ALTURA IRREGULAR

- * 41. Escrube-com-árvores fechado, altura irregular, latifoliado semidecíduo.
- 42. Escrube-com-árvores fechado, altura irregular, latifoliado decíduo.

VIII. ESCRUBE-COM-ÁRVORES-BAIXAS FECHADO, ALTURA IRREGULAR

- 43. Escrube-com-árvores-baixas fechado, altura irregular, de cica-dáceas.
- * 44. Escrube-com-árvores-baixas fechado, altura irregular, latifoliado semidecíduo.

IX. ESCRUBE FECHADO COM EMERGENTES

- 45. Escrube fechado com emergentes arbóreos, ambos latifoliados sempre-verdes.
- 46. Escrube fechado latifoliado sempre-verde, com emergentes de árvores latifoliadas sempre-verdes e fetos arborescentes.
- 47. Escrube fechado latifoliado sempre-verde com coníferas arbóreas emergentes.
- 48. Escrube fechado latifoliado sempre-verde com emergentes de árvores latifoliadas decíduas e coníferas arbóreas.
- 49. Escrube fechado latifoliado sempre-verde com emergentes arbóreos latifoliados decíduos.
- * 50. Escrube fechado com emergentes arbóreos, ambos latifoliados semidecíduos.
- 51. Escrube fechado latifoliado semidecíduo, com emergentes de coníferas-escrube.
- * 52. Escrube fechado com emergentes, ambos latifoliados decíduos.
- 53. Escrube fechado latifoliado decíduo com coníferas arbóreas emergentes.
- 54. Escrube fechado latifoliado decíduo com cactos emergentes.
- 55. Escrube fechado latifoliado decíduo com emergentes de árvores latifoliadas decíduas e cactos arbóreos.
- 56. Escrube fechado de elementos latifoliados decíduos e palmeiras, com cactos arbóreos emergentes.

X. ESCRUBE FECHADO

- 57. Escrube fechado latifoliado sempre-verde.
- 58. Escrube fechado de elementos latifoliados sempre-verdes e coníferas.
- 59. Escrube fechado de coníferas.
- 60. "Krummholz" fechado de coníferas.
- 61. Escrube fechado de fetos arborescentes.
- * 62. Escrube fechado de *Vellozia*.
- * 63. Escrube fechado de palmeiras.
- 64. Escrube fechado de bambus.
- 65. Escrube fechado de lobélías e senécios.
- * 66. Escrube fechado latifoliado semidecíduo.
- 67. Escrube fechado de elementos latifoliados semidecíduos e cactos arbóreos.
- * 68. Escrube fechado latifoliado decíduo.
- 69. Escrube fechado de elementos latifoliados decíduos e coníferas.
- 70. Escrube fechado de elementos latifoliados decíduos e cactos arbóreos.
- 71. Escrube fechado de elementos latifoliados decíduos e eufórbias cactiformes.
- 72. Escrube fechado de coníferas decíduas.

XI. ARVOREDO

- * 73. Arvoredo latifoliado sempre-verde.
- 74. Arvoredo de coníferas.
- 75. Arvoredo de coníferas e palmeiras.
- 76. Arvoredo de palmeiras.
- 77. Arvoredo de casuarinas.
- 78. Arvoredo de lobélías arbóreas e senécios arbóreos.
- * 79. Arvoredo latifoliado semidecíduo.
- 80. Arvoredo latifoliado decíduo.
- 81. Arvoredo de coníferas decíduas.

XII. ARVOREDO BAIXO

- 82. Arvoredo baixo latifoliado sempre-verde.
- 83. Arvoredo baixo de cicadáceas.
- 84. Arvoredo baixo de senécios arbóreos.
- 85. Arvoredo baixo de cactos.
- * 86. Arvoredo baixo latifoliado semidecíduo.
- * 87. Arvoredo baixo latifoliado decíduo.

XIII. ARVOREDO DE ESCRUBE-E-ÁRVORES

- 88. Arvoredo de escrube-e-árvores latifoliado sempre-verde.
- 89. Arvoredo de lobélías arbóreas e escrube latifoliado sempre-verde.
- 90. Arvoredo de palmeiras e escrube latifoliado sempre-verde.
- * 91. Arvoredo de escrube-e-árvores latifoliado semidecíduo.
- 92. Arvoredo de escrube-e-árvores latifoliado decíduo.

93. Arvoredo de *Yucca* arbórea e escrube latifoliado semi-decíduo.
94. Arvoredo de cactos arbóreos e escrube latifoliado decíduo.

XIV. ESCRUBE ABERTO

95. Escrube aberto latifoliado sempre-verde.
96. Escrube aberto agrupado latifoliado sempre-verde.
97. Escrube aberto de elementos latifoliados sempre-verdes e palmeiras.
98. "Krummholz" aberto de coníferas.
99. Escrube aberto de elementos latifoliados sempre-verdes e coníferas.
100. Escrube aberto de elementos latifoliados sempre-verdes e cactos.
101. Escrube aberto de palmeiras.
102. Escrube aberto de *Espeletia*.
103. Escrube aberto de *Puya*.
104. Escrube aberto de cactos.
105. Escrube aberto de cactos e agaves.
106. Escrube aberto de cactos, agaves e *Yucca*.
107. Escrube aberto de *Nolina*.
108. Escrube aberto de agaves.
109. Escrube aberto agrupado de eufórbias cactiformes.
110. Escrube aberto almofadado.
- * 111. Escrube aberto latifoliado semidecíduo.
- * 112. Escrube aberto de *Vellozia* e elementos latifoliados semidecíduos.
- * 113. Escrube aberto latifoliado decíduo.
114. Escrube aberto agrupado de elementos latifoliados decíduos, cactos e bromélias.
115. Escrube aberto de elementos latifoliados decíduos, *Yucca* e cactos.

XV. SAVANA ALTI-HERBÁCEA ARBÓREA

A. Tipos gramíneos

116. Savana altigraminosa sempre-verde com árvores latifoliadas sempre-verdes.
117. Savana altigraminosa sazonal com árvores latifoliadas sempre-verdes.
118. Savana altigraminosa sempre-verde com palmeiras arbóreas.
119. Savana altigraminosa sazonal com palmeiras arbóreas agrupadas.
120. Savana altigraminosa sazonal com *Pandanus* arbóreo.
121. Savana altigraminosa sazonal com *Casuarina* arbórea.
122. Savana altigraminosa sempre-verde com bambus altos agrupados.
- * 123. Savana altigraminosa sazonal com árvores latifoliadas semidecíduas.
124. Savana altigraminosa sazonal com árvores latifoliadas decíduas.

B. Tipos com fetos

125. Savana de fetos altos sempre-verdes com árvores latifoliadas sempre-verdes.

C. Tipos mistos de gramas e fetos

126. Savana de gramas e fetos altos sempre-verdes com árvores latifoliadas sempre-verdes.

XVI. SAVANA CURTI-HERBÁCEA ARBÓREA**A. Tipos gramíneos**

- 127. Savana curtigraminosa sempre-verde com árvores latifoliadas sempre-verdes.
- 128. Savana curtigraminosa sazonal com árvores latifoliadas sempre-verdes.
- 129. Savana curtigraminosa sazonal com coníferas arbóreas.
- 130. Savana curtigraminosa sazonal com palmeiras arbóreas.
- 131. Savana curtigraminosa sazonal com palmeiras arbóreas agrupadas.
- 132. Savana curtigraminosa sazonal com cicadáceas arbóreas.
- 133. Savana curtigraminosa sempre-verde com bambus altos agrupados.
- 134. Savana curtigraminosa sempre-verde com *Puya* arbórea.
- * 135. Savana curtigraminosa sazonal com árvores latifoliadas semidecíduas.
- * 136. Savana curtigraminosa sazonal com árvores latifoliadas decíduas.

B. Tipos com fetos

- 137. Savana de fetos baixos sempre-verdes com árvores latifoliadas sempre-verdes.

C. Tipos musgosos

- 138. Savana musgosa com coníferas arbóreas decíduas.

D. Tipos líquenosos

- 139. Savana líquenosa com coníferas arbóreas decíduas.

XVII. SAVANA ALTI-HERBÁCEA COM ESCRUBE-E-ÁRVORES

- * 140. Savana altigraminosa sazonal com escrube-e-árvores latifoliado semidecíduo.

XVIII. SAVANA CURTI-HERBÁCEA COM ESCRUBE-E-ÁRVORES

- 141. Savana curtigraminosa sempre-verde com escrube-e-árvores latifoliado sempre-verde.
- * 142. Savana curtigraminosa sazonal com escrube-e-árvores latifoliado semidecíduo.
- * 143. Savana curtigraminosa sazonal com escrube-e-árvores latifoliado decíduo.

XIX. SAVANA ALTI-HERBÁCEA COM ESCRUBE**A. Tipos gramíneos**

- 144. Savana altigraminosa sempre-verde com escrube latifoliado sempre-verde.
- 145. Savana altigraminosa sazonal com escrube latifoliado sempre-verde.

- * 146. Savana altigraminosa sazónaria com escrube latifoliado semi-decídúo.
- 147. Savana altigraminosa sazónaria com escrube latifoliado decídúo.

B. Tipos com fetos

- 148. Savana de fetos altos sempre-verdes com *Espeletia*-escrube.

XX. SAVANA CURTI-HERBÁCEA COM ESCRUBE

A. Tipos graminosos

- 149. Savana curtigraminosa sempre-verde com escrube latifoliado sempre-verde.
- 150. Savana curtigraminosa sazónaria com escrube latifoliado sempre-verde.
- 151. Savana curtigraminosa sazónaria com coníferas-escrube.
- 152. Savana curtigraminosa sempre-verde com casuarinas-escrube.
- 153. Savana curtigraminosa sazónaria com palmeiras-escrube.
- 154. Savana curtigraminosa sempre-verde com fetos arborescentes.
- 155. Savana curtigraminosa sazónaria com *Yucca*-escrube.
- 156. Savana curtigraminosa sazónaria com *Yucca*, cactos e escrube áfilo.
- 157. Savana curtigraminosa sempre-verde com lobélias-escrube.
- 158. Savana curtigraminosa sempre-verde com senécios-escrube.
- 159. Savana curtigraminosa sazónaria com cactos-escrube.
- 160. Savana curtigraminosa sazónaria com *Nolina*-escrube.
- 161. Savana curtigraminosa sazónaria com escrube almofadado.
- * 162. Savana curtigraminosa sazónaria com escrube latifoliado semi-decídúo.
- * 163. Savana curtigraminosa sazónaria com escrube latifoliado decídúo.

B. Tipos ervosos

- 164. Savana curti-ervosa sempre-verde com escrube latifoliado sempre-verde.
- 165. Savana curti-ervosa sazónaria com elementos de escrube latifoliados decídúos e suculentos.

C. Tipos gramino-ervosos

- 166. Savana curtigramino-ervosa sazónaria com escrube latifoliado decídúo.

D. Tipos musgosos

- 167. Savana musgosa com coníferas-escrube.

XXI. ARVOREDO ESPARSO

- 168. Arvoredo esparso latifoliado sempre-verde.
- 169. Arvoredo esparso de cactos arbóreos
- 170. Arvoredo esparso latifoliado decídúo.

XXII. ARVOREDO ESPARSO DE ESCRUBE-E-ÁRVORES

- 171. Arvoredo esparso de escrube-e-árvores latifoliado decídúo.

XXIII. ESCRUBE ESPARSO

- 172. Escrube esparso latifoliado sempre-verde.
- 173. Escrube esparso áfido.
- 174. Escrube esparso de palmeiras.
- 175. Escrube esparso de *Welwitschia*.
- 176. Escrube esparso de cactos.
- 177. Escrube esparso de eufórbias cactiformes.
- 178. Escrube esparso latifoliado decíduo.

XXIV. CAMPO ALTI-HERBÁCEO

A. Tipos gramíneos não conspícuamente tufosos

- 179. Campo altigrâmico sempre-verde.
- 180. Campo altigrâmico sazonal.

B. Tipos gramíneos conspícuamente tufosos

- 181. Campo altigrâmico tufoso sempre-verde.
- 182. Campo altigrâmico tufoso sazonal.

C. Tipos ervosos

- 183. Campo alti-ervoso sempre-verde.
- 184. Campo alti-ervoso sazonal.

D. Tipos mistos graminó-ervosos

- 185. Campo altigrâmico-ervoso sempre-verde.
- 186. Campo altigrâmico-ervoso sazonal.

E. Tipos com fetos

- 187. Campo de fetos altos sempre-verdes.

F. Tipos com algas marinhas

- 188. Campo de algas marinhas altas.

XXV. CAMPO CURTI-HERBÁCEO

A. Tipos gramíneos não conspícuamente tufosos

- 189. Campo curtigrâmico sempre-verde.
- * 190. Campo curtigrâmico sazonal.
- 191. Campo curtigrâmico efêmero.

B. Tipos gramíneos conspícuamente tufosos

- 192. Campo curtigrâmico tufoso sempre-verde.
- 193. Campo curtigrâmico tufoso sempre-verde com ervas almofadadas.
- 194. Campo curtigrâmico tufoso sazonal.

C. Tipos ervosos

- 195. Campo curti-ervoso sempre-verde.
- 196. Campo curti-ervoso sazonal.
- 197. Campo curti-ervoso efêmero.

D. Tipos com ervas almofadadas

- 198. Campo de ervas baixas almofadadas.

E. Tipos graminó-ervosos

- 199. Campo curtigramino-ervoso sempre-verde.
- 200. Campo curtigramino-ervoso sazonnrio.

F. Tipos de graminóides e ervas almofadadas

- 201. Campo sempre-verde de graminóides e ervas almofadadas.

G. Tipos de graminóides e fetos

- 202. Campo sazonnrio de graminóides e fetos baixos.

H. Tipos musgosos

- 203. Campo musgoso (ou tapete musgoso).

I. Tipos musgo-liquenosos

- 204. Campo musgo-liquenososo (ou tapete musgo-liquenososo).

J. Tipos liquenosos

- 205. Campo liquenososo (ou tapete liquenososo).

K. Tipos com algas marinhas

- 206. Campo de algas marinhas baixas (ou tapete de algas marinhas).

L. Tipos de algas microscópicas ou caráceas

(Algas filamentosas microscópicas formando um tapete grosso sobre água ou sobre rocha ou solo úmido.)

- 207. Tapete algoso.

XXVI. CAMPO ESPARSO

A. Tipos graminosos

- 208. Campo graminoso esparso sempre-verde.
- 209. Campo graminoso esparso sazonnrio.
- 210. Campo graminoso esparso efêmero.

B. Tipos ervosos

- 211. Campo ervoso esparso sempre-verde.
- 212. Campo ervoso esparso sazonnrio.
- 213. Campo ervoso esparso efêmero.

C. Tipos com ervas almofadadas

- 214. Campo esparso de ervas almofadadas.

D. Tipos mistos

- 215. Campo esparso de ervas e graminóides perenifólios e ervas almofadadas.

E. Tipos musgosos; tipos liquenosos

- 216. Campo musgoso esparso; campo liquenososo esparso; campo musgo-liquenososo esparso.

OUTROS CRITÉRIOS

Além dos três mencionados, outros critérios poderão ser usados, mas,

nesse caso, a expressão seria mais longa, formando uma espécie de descrição, em vez de um simples nome. Entre os da lista abaixo, o n.º 2, *altura de escrube*, é o de maior utilidade.

1. *Altura de árvore*: alta, mais de 20 m; *mediana*, 7-20m.
2. *Altura de escrube*: alto, mais de 3 m; *mediano*, de mais de 1 1/2 até 3m; *baixo* 1/2 — 1 1/2m; *anão*, menos de 1/2m. Com várias alturas, tôdas conspícuas, usa-se “baixo a alto”, etc., ou “... de altura irregular”.
3. *Espinhosidade*: “mata espinhosa”, “escrube espinhoso”, etc., quando essa característica é predominante.
4. *Tortuosidade*: “mata baixa torta”, “escrube torto”, etc., quando essa característica é predominante. Este critério foi usado somente no caso extremo de um “krummholz”, na lista principal que precede.
5. *Consistência foliar*: *esclerófilo*, se este caráter predomina; *semi-esclerófilo*, se alguns indivíduos são bem esclerófilos e outros não.
6. *Presença de lianas*: quando não é o componente principal mas, é conspícuo, acrescenta-se “... com lianas” no fim da expressão.
7. *Presença de epífitas*: quando conspícuo, acrescenta-se “... com orquídeas epífitas”, “... com bromélias epífitas”, “... com fetos epífitos”, etc., no fim da expressão.
8. *Chão aberto*: para se distinguir as camadas herbáceas de cobertura aberta, das camadas herbáceas fechadas, em vegetação onde a camada arbórea ou de escrube não é fechada, acrescenta-se “... com chão aberto” no fim da expressão.

9. *Grau de perturbação*: para árvores e escrube: *virgem*; *primário* (quando não se tem certeza de que é virgem); *primário parcialmente explorado*; *primário parcialmente queimado*; *primário parcialmente derrubado*; *mata primária derrubada com árvores remanescentes espalhadas*; *misto primário-secundário*; *mata secundária* (ou *escrube fechado secundário*) *com árvores remanescentes espalhadas*; *secundário*; *secundário parcialmente explorado*; *secundário parcialmente queimado*; *secundário parcialmente derrubado*; *ligeiramente pastado*; *muito pastado*, etc. Para a camada herbácea: *virgem* (i. é, nunca arada ou cultivada); *recentemente queimada*; *periódicamente queimada*; *ligeiramente pastada*; *muito pastada*; *erodida*, etc.

Se o estado primitivo era diferente do atual e é conhecido, pode-se acrescentar o estado original no fim da expressão, entre parênteses, precedido por “originalmente...” ou “primitivamente...”.

TERMINOLOGIA

“Arvoredo” foi escolhido para traduzir “woodland”. É uma formação arbórea com dossel aberto e com o sobosque arbustivo *não* fechado (isto é, podendo ser aberto, esparso e até mesmo ausente). Outra possibilidade é “bosque”. Mas, esta palavra tem vários outros sentidos em relação à vegetação e que se referem a outras densidades e alturas. Além disso, em espanhol, “bosque” é uma das palavras usadas no sentido geral de *outra* categoria considerada neste trabalho, o escrube.

No rodapé, arvoredo foi definido no sentido geral. Com este sentido, arvoredo entrou na formação de três categorias estruturais: “arvoredo”

(pròpriamente dito), "arvoredo baixo" e "arvoredo de escrube-e-árvores". Quando o adjetivo "esparso" é ligado ao t rmo arvoredo, o sentido geral   estendido para expressar as categorias "arvoredo esparso" e "arvoredo esparso de escrube-e- rvores".

A palavra ingl sa "scrub" parece n o ter nenhum equivalente em portugu s. "Arbustaria" ("shrubbery")   s mente uma das poss veis formas de "scrub", isto  , um "scrub" composto exclusivamente de arbustos bem definidos. "Matagal"   uma vegeta  o ramosa, dentro da qual   dif cil enxergar e penetrar; o t rmo n o pode ser usado porque se refere tanto a um "scrub" fechado ("thicket") como a uma mata verdadeira de sobosque fechado e ramoso. "Scrub" pode ser de qu lquer densidade: fechado, aberto ou esparso. Refere-se a uma camada ou a uma vegeta  o inteira, de plantas, nem t picamente arb rea, nem t picamente herb cea. Na falta de um t rmo em portugu s para expressar  sse conceito, foi introduzida a forma portuguesa escrube.

AGRADECIMENTO

Agrade o a participa  o de Liene T. Eiten, na reda  o do resumo em portugu s.

VEGETATION FORMS

ERRATA E ALTERAÇÕES

Secretaria da Agricultura
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ERRATA

Página e Lugar (Page & Place)	Onde se lê (For)	Leia-se (Read)
iii, line 4	heigh	height
15, paragraph 4, line 2	element	elements
31, par. 1, lines 5 & 6	difference	differences
50, item nº 98, line 2	Rocky Muntains	Rocky Mountains
50, item nº 99, line 4	warrent	warrant
51, item nº 110, line 2	Kerguelen Island;	Kerguelen Island);
59, item nº 187, line 2	<u>Glechenia</u>	<u>Gleichenia</u>
63, item nº 1, line 2	3-7 m <u>tall</u> ,	3-7 m tall,
64, par. 1, line 1	lwoodlands"	"woodlands".
64, par. 1, line 3	(LEAVE OUT THIS WHOLE LINE) (NÃO INCLUA ESTA LINHA)	
64, par. 4, line 20	all-green	all-green
70, 1st footnote, line 2 (1ª roda-pé, linha 2)	camadas	camada
71, middle of page	lista baixo	lista abaixo
85, item nº XXIV A	conspìcuamene	conspìcuamente

ALTERAÇÕES DO AUTOR, APÓS PUBLICAÇÃO DO LIVRO

Página e Lugar (Page & Place)	Onde se lê (For)	Leia-se (Read)
10, paragraph 4, line 12	scrub	woodland
14, par. 4, line 6	same the region	same region
14, par. 5, line 6	not that is	not that it is
36, top line	<u>Sansevieria</u>	<u>Sanseviera</u>
44, item nº 42, line 1	<u>uneven trees</u>	<u>uneven closed trees</u>
44, item nº 47, last line	emergent conifers	emergent tree-conifers
49, item nº 90, line 1	<u>Woodland of palms</u>	<u>Woodland of tree-palms</u>
63, item nº 6, line 1	as growth form	as a growth form
64, par. 5, line 1	following, list	following list
66, under "Griggs, R.F."	Ecology	<u>Ecology</u>
68, subtitle	Uma classificação	Classificação
69, penultimate line	no aspecto	ao aspecto
70, line 11	policaulescente,	policaulescentes,

ALTERAÇÕES DO AUTOR, APÓS PUBLICAÇÃO DO LIVRO (continuação)

Página e Lugar (Page & Place)	Onde se lê (For)	Leia-se (Read)
77, line 8	<u>Sansevieria</u>	<u>Sansevieria</u>
78, line 21	viva ou sêca mais	viva ou sêca mas,
78, line 27	categorias estruturais e marcadas	categorias estruturais, marcadas
80, item nº 37	mata baixa de	mata baixa aberta de
80, item nº VII	ESCRUBE-COM-ÁRVORES	ESCRUBE-E-ÁRVORES
80, item nº VIII	"	"
80, item nº 41	Escrube-com-árvores	Escrube-e-árvores
80, item nº 42	"	"
80, item nº 43	"	"
80, item nº 44	"	"
81, item nº 90	palmeiras e	palmeiras arbóreas e
84, item nº 163	* 163	163